

# Current Science



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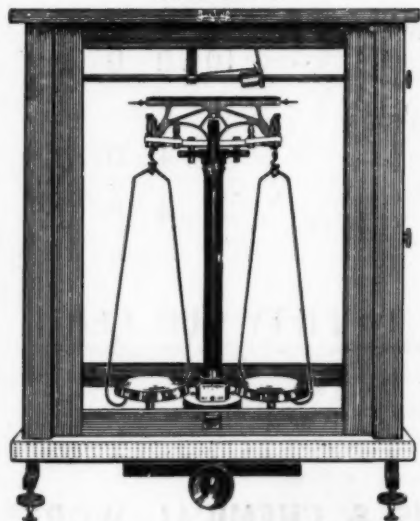
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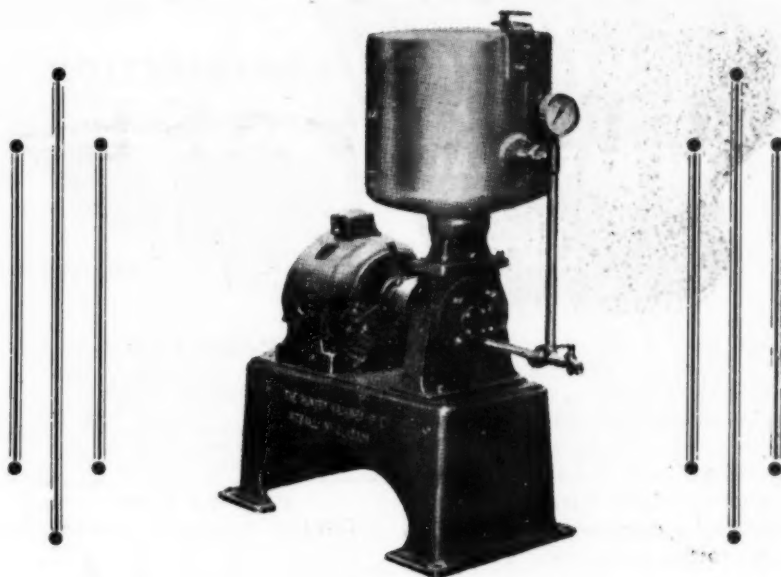
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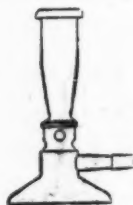
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Dated 15th March 1948

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Secretaries

# Current Science

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MARCH 1948

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## DYNAMIC X-RAY REFLECTIONS IN CRYSTALS\*

### 1. INTRODUCTION

DIAMOND, by reason of its exceptional properties, has played a notable part in the development of our notions concerning the solid state of matter. For instance, when Einstein put forward his famous theory of specific heats, it was the only known solid exhibiting a marked variation of specific heat with temperature, and one may well believe that it was the behaviour of diamond which inspired Einstein to apply quantum theory to the problem. More recent studies on diamond indeed suggest that the properties of this remarkable substance are the pathway to a correct appreciation of the theory of the solid state. That this remark is applicable to the theory of the

propagation of X-rays in crystals and of the attendant phenomena forms the major theme of this address.

Diamond has interested the writer ever since 1930, and numerous investigations with it undertaken at his suggestion have appeared in the earlier volumes of the *Indian Journal of Physics* and subsequent to 1933 in the *Proceedings of the Indian Academy of Sciences*. Early in the year 1940, in connection with certain spectroscopic investigations, a few octahedral cleavage plates of diamond were acquired. These formed the beginnings of a collection that has since grown up very considerably. A powerful X-ray set-up was available at the Institute, and Dr. P. Nilakantan undertook to obtain some Laue patterns with diamond, using a copper target as a source of mono-

\* Jubilee Address to the South Indian Science Association delivered by Sir C. V. Raman at Bangalore, on the 25th March 1948.



chromatic X-radiation. The photographs revealed a phenomenon of such a remarkable character and so clearly incapable of explanation on the basis of familiar X-ray theory that the writer had no hesitation in announcing in *Current Science* of April 1940 the discovery of a new X-ray effect, introducing it in the following words: "The new X-ray phenomenon described and illustrated in the present communication has in its physical nature, something in common with both the Laue and the Compton effects: it is a specular reflection of X-rays by

thereby confirming the quantum-mechanical nature of the effect. Using fine slits with correspondingly long exposures, the reflections were found to be extremely sharp, thus precluding any explanation of them as due to the thermal X-ray scattering. The appearance of the reflections at various settings of the crystal was explained in the *Current Science* article on the basis of certain considerations regarding the phases of the excited vibrations. These considerations and the formula for the geometric law of the quantum reflection derived



FIG. 1. Dynamic X-Ray Reflections by Diamond.  $\text{CuK}\alpha$  Radiation  
(After Raman and Nilakantan, April 1940)

crystals but with a change of frequency explicable only on quantum-mechanical principles." The article went on to suggest that the observed reflections had their origin in the excitation of the eigenvibrations of the diamond structure by the incident X-radiations. It was also pointed out that in view of the known high frequency of these eigenvibrations, the thermal agitation in the crystal could not be the operative cause of the reflections. Subsequent investigations showed that their intensity was not notably influenced by heating the crystal or cooling it down to liquid-air temperature,

therefrom were confirmed with all desirable precision by exact measurements.

The new ideas and principles emerging from the case of diamond naturally suggested a series of investigations with other crystals. The results were published in a series of seven papers in the *Proceedings of the Indian Academy of Sciences* between May and November 1940, and finally in a symposium of fifteen papers under the general title of the "Quantum Theory of X-Ray Reflection" as the October 1941 issue of the *Proceedings*. The subject was then laid aside. It appears opportune now to



return to it, and that some years have elapsed in the interval has not been altogether a disadvantage. For, the studies on several allied topics made at Bangalore during these seven years have cleared the ground for a proper understanding of crystal physics generally and of X-ray physics in particular. Most of the criticisms of the Bangalore publications which were put forward at the time by different writers are seen in the light of the later developments to be without substance or justification.

faces, the phase of the motion being opposite in every pair of adjacent cells of the pattern. The configuration of the nodal pattern would be determined by several factors, *vz.*, the size of the crystal, its form and the external boundary conditions, the elastic constants and their variation with direction, and it would also be different for each different mode with its particular frequency. It would not be easy—even if it were theoretically possible—to determine the pattern even for a single



FIG. 2. Dynamic X-Ray Reflections by Diamond.  $\text{CuK}\alpha$  and  $\text{K}\beta$  Radiations  
(After Raman and Nilakantan, April 1940)

## 2. THE THERMAL SCATTERING OF X-RAYS

In considering the phenomena attending the passage of X-rays through a crystal and resulting from the movements of the atoms in it (due to the thermal agitation or other cause), it is desirable in the first instance to fix our attention on such of these movements as can be identified with the elastic vibrations of the solid. There would be an immense number of such movements or normal vibrations possible. Each of these modes extends through the entire volume of the crystal and has a distinctive frequency and a characteristic pattern of nodal sur-

one of the modes, much less for all of the immense number which need to be considered. We notice, however, that all the factors which are determinative of the nodal pattern are of a *macroscopic* character. Hence, we are justified in inferring that in no case would the nodal pattern bear any particular or specifiable relation to the atomic architecture of the crystal, under which term we refer to the position of the atomic layers and of the individual atoms. The situation here depicted is seen to have important consequences when we proceed to consider the optical aspects of the problem. Fixing our

attention on a particular mode of elastic vibration of frequency  $\nu^*$ , we note that each atom in the track of the X-ray beam can be regarded as a source of secondary radiations of frequency  $\nu$ ,  $\nu + \nu^*$ , and  $\nu - \nu^*$ ,  $\nu$  being the frequency of the incident X-radiation. The strength of the radiations of frequencies ( $\nu \pm \nu^*$ ) would be determined by the amplitude of oscillation of the atoms, while the phases of the scattered radiations as received at any point would be determined by the optical paths and by the phase of the oscillation of the atom. Since the latter phase is reversed whenever we pass from one side to the other of each nodal surface in the elastic vibration, it follows that the phases of the scattered radiations would be reversed at the same time. Hence, in the final summation over all the atoms in the track of the X-ray beam, the radiations from the atoms included in the successive cells of the nodal pattern would tend to cancel out by interference. Any resultant left over would arise from the varying amplitudes of the vibrations of the atoms and the varying density of their distribution; but since these variations are uncorrelated, the net result would be unpredictable for any particular  $\nu^*$  and would also be different for each different  $\nu^*$ .

We thus arrive at the conclusion that the scattered radiations from the atoms arising from the elastic vibrations in the solid cannot possibly conspire to build up anything in the nature of a diffraction pattern having a recognizable relationship to the atomic structure of the crystal. That a contrary conclusion has been reached by various writers is evidently due to the erroneous nature of the premises on which they have proceeded to consider the problem. We may remark in this connection that in the case of a finite crystal, it is not permissible to postulate the propagation of plane elastic waves in various directions and to consider the optical results of each such wave independently. The proper analysis of the elastic vibration is into a set of normal vibrations, each with its own pattern of nodal surfaces determined by the form of the crystal and other factors as stated above.

### 3. THE ORIGIN OF THE EXTRA SPOTS

The foregoing remarks make it evident that it is not possible to explain the so-called "diffuse" spots in the Laue patterns of crystals other than diamond on the basis of the elastic vibrations excited in

them by thermal agitation or otherwise. This is obvious in the case of diamond by virtue of the observed sharpness or specu-

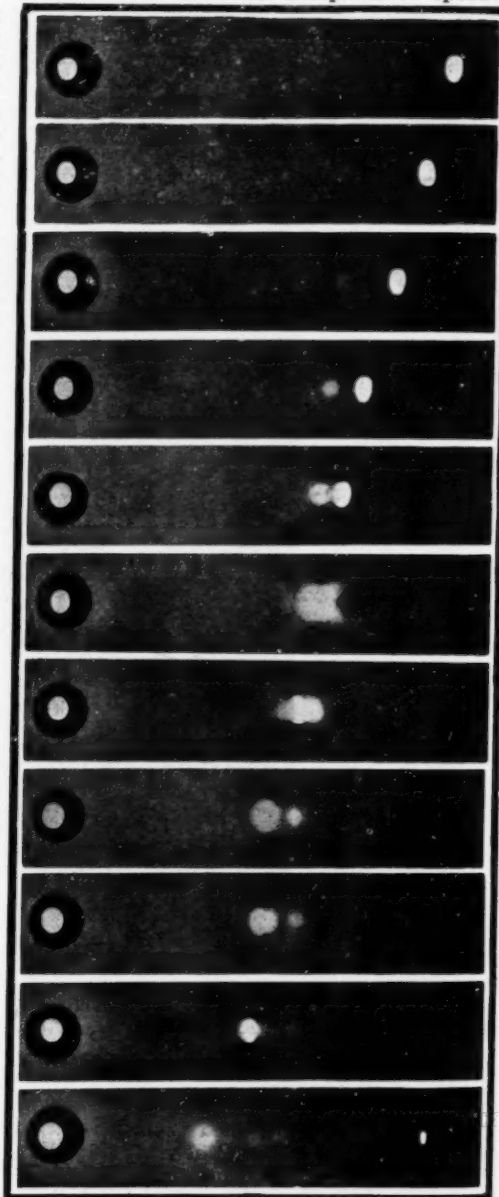


FIG. 3. Sequence of Changes in (111) Reflections by Diamond with Alteration of Crystal Setting (After Raman and Nilakantan, November 1940)

lar character of its extra reflections, but it is equally true for all crystals. In other words, the phenomena exhibited by diamond are exceptional only in the sense that all the properties of diamond are exceptional, *viz.*, they stand out so clearly as to leave little room for being misunderstood. The criticisms of the Bangalore work put forward by various writers who have sought to brush aside the facts observed with diamond on the basis of *ad hoc* explanations or by writing them down as "secondary" phenomena, are thus clearly misconceived.

In the Laue pattern of an octahedral cleavage plate of diamond obtained when the X-ray beam is parallel to a trigonal axis, the extra spots appear symmetrically

nal boundary and the conditions there subsisting. Even in the purely conceptual case of an infinite crystal where the elastic disturbances can be considered as waves, different wave-lengths and directions of propagation can co-exist, thereby precluding the possibility of giving rise to sharply defined "extra" spots. For the same reason, therefore, the atomic movements in diamond which give the observed reflections cannot be described as waves whose wave-lengths and directions are arbitrary in the same manner as those of elastic waves in an infinite solid. Indeed, the analysis of the positions of the reflections by the (111) planes of diamond as actually observed for various settings shows that the planes of constant phase in

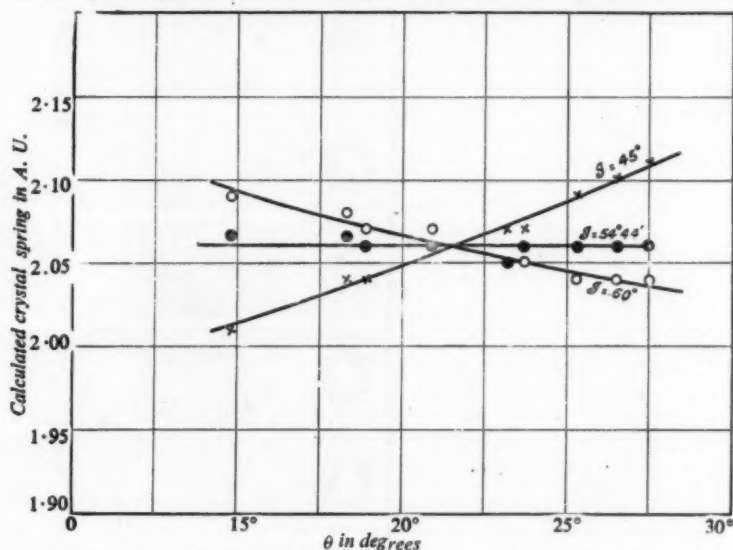


FIG. 4. Coincidence of Phase Waves in Diamond with Cubic Planes

(After Raman and Nilakantan, November 1940)

placed about that axis, and are readily recognized as specular reflections by the (111) spacings of the incident monochromatic radiation, analogous to the ordinary or static X-ray reflections, but obeying a different geometrical law. It follows that the atomic movements in the crystal which give rise to them are related to the structure of the crystal in a precisely definable manner, instead of being entirely uncorrelated with them as in the case of the elastic vibrations. As we have seen, the incapacity of the elastic modes of vibration to give rise to such effects arises from the fact that they are determined by macroscopic factors, including especially the existence of an exter-

nal boundary and the conditions there subsisting. Even in the purely conceptual case of an infinite crystal where the elastic disturbances can be considered as waves, different wave-lengths and directions of propagation can co-exist, thereby precluding the possibility of giving rise to sharply defined "extra" spots. For the same reason, therefore, the atomic movements in diamond which give the observed reflections cannot be described as waves whose wave-lengths and directions are arbitrary in the same manner as those of elastic waves in an infinite solid. Indeed, the analysis of the positions of the reflections by the (111) planes of diamond as actually observed for various settings shows that the planes of constant phase in

Thus, alike from theoretical considerations and from the experimental facts, and as in the case of diamond, so also for all other crystals, it is clear that the origin of the "extra" spots has to be sought in types of atomic movement which are precisely related to the structure of the crystal, and which unlike the familiar waves of elastic theory,

are uninfluenced by the presence of an external boundary, and whose planes of constant phase are restricted to certain specified orientations. By a simple process of exclusion, we are forced to the conclusion that these movements are the eigenvibrations of the crystal structure which manifest themselves in spectroscopic studies with crystals, and further, that such eigenvibrations possess characters wholly different from the vibrations pictured in the classical theory of elasticity.

and of their relationship to the spectroscopic phenomena. Such an approach has been made in the introductory paper of a symposium on "The Dynamics of Crystal Lattices", published by the *Indian Academy of Sciences* as its *Proceedings* for November 1943. More recently, the spectroscopic consequences of the new theory have been worked out and the results compared with the experimental facts in numerous cases, viz., diamond, magnesium oxide, the alkali halides, etc. The results have been published as a symposium



FIG. 5. Dynamic Reflections by Sodium Nitrate at 225°C.  
(After Raman and Nilakantan, May 1940)

#### 4. THE EIGENVIBRATIONS OF CRYSTAL STRUCTURE

Our argument thus leads us to recognize the fundamental relationship between the physics of X-ray propagation in crystals and the physics of their spectroscopic behaviour. It also shows that the older views which sought to force the spectroscopic picture of crystal behaviour into a pattern similar to that of its elastic vibrations are fundamentally erroneous. Indeed, the X-ray phenomena observed with diamond compel us to make a fresh approach to the theory

of the eigenvibrations of crystal structures of nineteen papers on "The Vibration Spectra of Crystals" forming the *Proceedings of the Indian Academy of Sciences* for December 1947. The theory is so successful in explaining the facts of observation, including such as are wholly unintelligible on the basis of the older theories, as to leave no room for doubt regarding the essential correctness of the new approach.

The main result of the new theory is that, whereas on the older theories the vibrations both in the acoustic and optical ranges of frequency yield continuous spectra, they

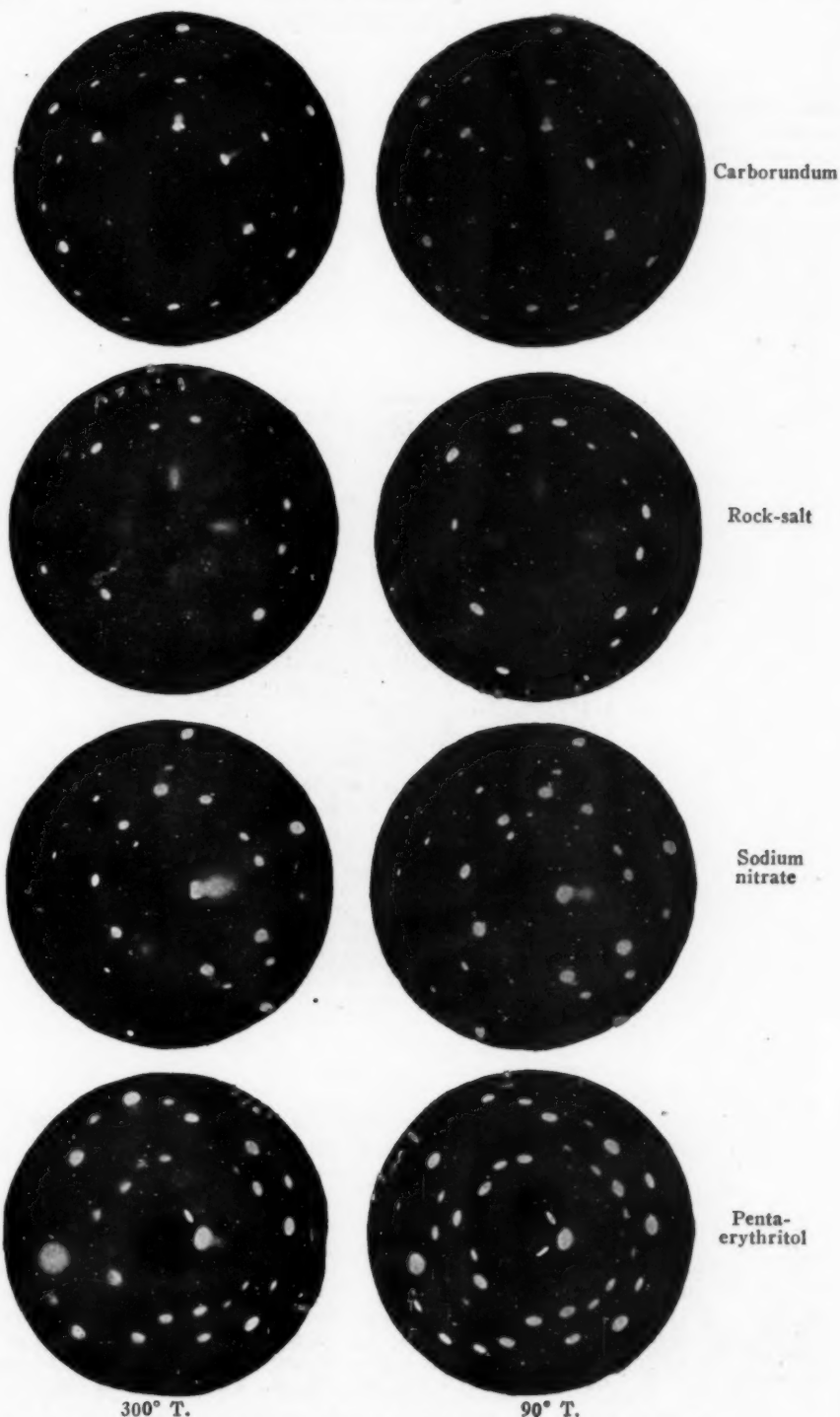


FIG. 6. Quantum X-Ray Reflections by Crystals at 30°C. (*Left*) and -180°C. (*Right*)  
(After C. S. Venkateswaran, September 1941)



appear in the new theory as a set of modes with sharply-defined monochromatic frequencies,  $(24p-3)$  in number, there being  $p$  atoms in the unit cell of the crystal lattice. In  $(3p-3)$  of these modes, the vibrations has the same amplitude and phase in adjacent cells of the lattice, while in the remaining  $21p$  modes, the amplitude is the same while the phase alternates in successive cells along one, two or all three of the axes of the lattice. The actual number of discrete frequencies would be much less than  $(24p-3)$ , if the crystal belongs to the higher symmetry classes. In the case of diamond, for instance, the  $(3p-3)$  frequencies reduce to only one, where the  $21p$  frequency reduce to seven in number. The vibrations and their respective frequencies may be regarded as characteristic properties of the dynamic unit of the crystal structure which is a super-cell with twice the dimensions and eight times the volume of the unit cell of the lattice. It may be remarked that the 3 excluded degrees of freedom form the residue which goes over into the spectrum of the elastic vibrations of the crystal.

which the evidence of excitation is furnished by spectroscopic study, e.g., observations of the spectrum of the scattered light, of the absorption in the infra-red, and also in favourable cases of the absorption in the

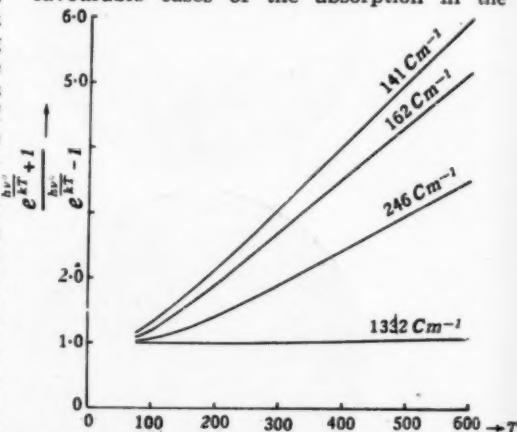


FIG. 7. Temperature Factor of Quantum Reflection, Theoretical (After Roman, September 1911)

visible spectrum, and of the luminescence spectrum at low temperatures. The mono-

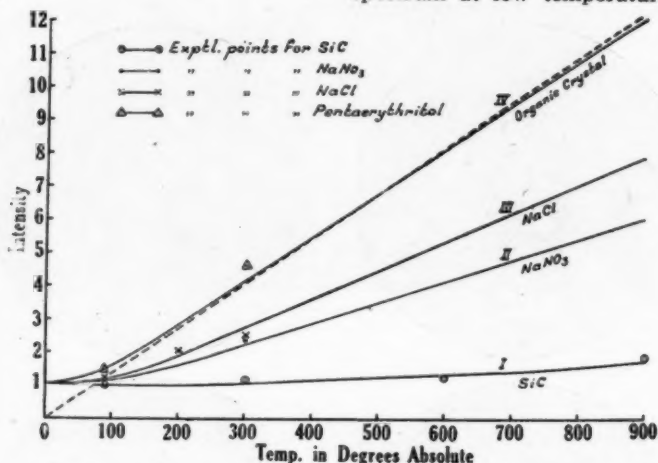


FIG. 8. Temperature Factor of Quantum Reflection, Experimental (After C. S. Venkateswaran, September 1941)

##### 5. EXCITATION OF THE EIGENVIBRATIONS

It is possible to excite the eigenvibrations of a crystal in various ways, the most obvious and universal method being that of thermal agitation which is always effective, provided the temperature is sufficiently high. We have also various optical methods in

chromatic character of the vibration frequencies comes directly into evidence in all such cases, irrespective of the particular method of excitation adopted, showing thereby that it is a characteristic property of crystal structure and not a consequence of the particular method of excitation employed. The activity of the individual modes



may, however, differ in respect of the different methods of excitation. For instance, in the cases of light-scattering and of infrared absorption, they are complementary and mutually exclusive in respect of the fundamental frequencies in the case of

with appreciable intensities in the optical methods of excitation indicates that the vibrations excited are highly localised, and that in consequence, the vibration amplitudes are comparable with the interatomic distances. If, on the other hand, the excitation

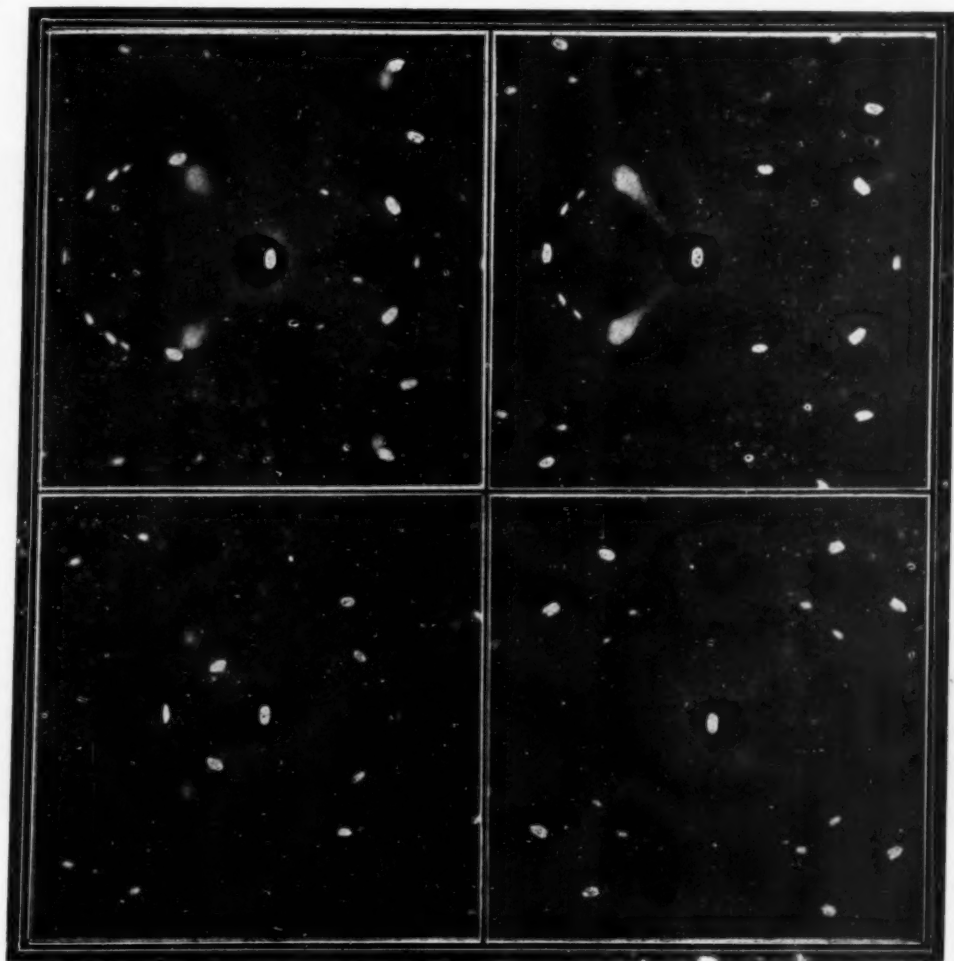


FIG. 9. Dynamic X-Ray Reflections by Hexamethyl Tetramine  
(After C. S. Venkateswaran, October 1941)

crystals possessing a centre of symmetry. This feature disappears when we consider the overtones and summations of the fundamental frequencies where anharmonicity, mechanical or optical, comes into play. The appearance of overtones and summations

extends over a large volume in the crystal, the energy of a quantum of the particular frequency distributed over such volume would result in the amplitudes being infinitesimal and hence incapable of giving rise to overtones or summations with appre-

ciable intensities. On the other hand, in the excitation which results in dynamic X-ray reflections, we must picture the vibration as occurring in the same phase or with slowly varying phases over an extended volume of the crystal, since otherwise no observable reflection could result. The larger the volume in which the excitation occurs, the more sharply defined would the resulting reflections be. The extreme sharpness of the dynamic reflections in the case of diamond where the bonding between each

dynamic reflection. The amplitude of vibration, would also be dependent on the masses and binding forces involved. Hence, it is quite possible for crystals which give only "diffuse" spots nevertheless to exhibit them with notable intensities.

#### 6. INFLUENCE OF TEMPERATURE

In many cases, and especially where the binding forces are weak or the atomic masses are large and hence the eigenfrequencies are low, the eigenvibrations would be excited by thermal agitation, and hence

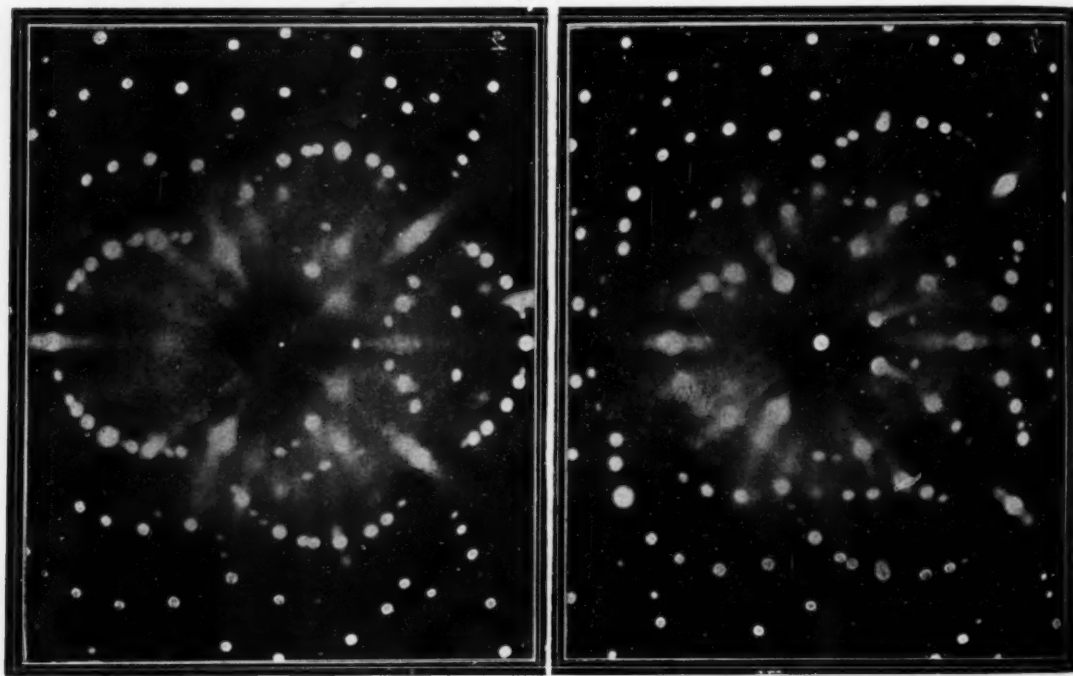


FIG. 10. Dynamic X-Ray Reflections by Calcite for Different Settings  
(After Nilakantan and Nayar, October 1941)

lattice cell and the next is strong is readily understood on this basis, while the diffuseness of the "extra" spots in weak crystals, such as for instance organic compounds, is also intelligible as a consequence of the weakness of the binding between the successive cells of the structure. It should be remarked that the restriction in the volume of excitation would result in an increase of the amplitude of vibration, and this would exactly set off the decrease in the number of lattice cells which co-operate to give a

such thermally excited eigenvibrations would have to be considered in respect of the X-ray phenomena as well. The theoretical position is somewhat analogous to that arises in the case of the excitation by optical methods, viz., the scattering of light, where we are concerned with both positive and negative shifts of frequency in the spectrum of the diffused light. Instead of the ground state, the thermally excited state of eigenvibration would be the starting point for their excitation by the

incident X-radiation, and hence it can occur in either direction, viz., further excitation or a de-excitation. The dynamic reflections arising in either way would appear superposed in the finally observed result, and the net consequence to be theoretically expected would be an increase in the intensity of the reflection with rising temperature, besides subsidiary effects such as increase in diffuseness. The magnitude of the increase of intensity would depend on the frequencies of the eigenvibrations which are effective in giving the observed reflection, and the proportionate increase would be the smaller, the higher the frequency or frequencies under consideration. *Per contra*, the intensity would diminish when the temperature is lowered, but since the quantum-mechanical excitation would persist in every case, the reflection would not disappear even at the lowest temperatures but would on the other hand persist. The intensity at low temperatures would be relatively the largest in the case where the eigenvibrations involved would have relatively the highest frequencies. There is no reason to expect any notable dependance of

the magnitude of the temperature variation on the setting of the crystal at which the dynamic X-ray reflections are recorded.

#### 7. DEPENDENCE ON CRYSTAL STRUCTURE

It will be evident from what has been stated above that the pattern of dynamic X-ray reflections by a crystal would be largely determined by the number and nature of its eigenvibrations and their frequencies, and also on the manner in which these eigenvibrations influence the structure amplitudes of the various crystal planes. Each individual case would have to be considered on its merits as in the case of static X-ray reflections, but general considerations regarding the nature of the oscillations possible in ionic, molecular or layer lattices would enable us to predict or at least understand the general nature of the dynamic X-ray patterns to be expected in these respective cases. But it would take us beyond the scope of the present article to enter into these details.

C. V. RAMAN.

*Note.*—The cost of printing this article has been met from a generous grant from the National Institute of Sciences, India.

## EDITORIAL NOTE

### SCIENTIFIC FILMS

THE influence of Science and its technological applications on the social structure of modern civilisation is becoming increasingly apparent. Science is ever in the process of modifying the relations of man to his natural environment and between social groups of human beings. It is clear that scientific research and knowledge offer man the alternatives between improving and degrading social life: they can help or obstruct solution of social problems.

In democratic countries the choice of the alternatives largely depends, not so much on the few men at the laboratory bench, but on the large majority who elect their ruling representatives. And it is a truism that the more enlightened and responsible the electorate, the greater the calibre of the administrators and higher the efficiency of administration. Therefore, the essential prerequisite for a true and successful democracy is a liberal education which includes a certain basic knowledge of science that enables the farmer and the factory hand, the trader and the consumer appreciate advances in applied and technological branches.

In free India, where there is yet enormous scope for application of available information and technological processes, science has a conspicuous role to play before she could come on a par with the Western world. We have to look

to science to unfold a new era of sustained economic prosperity, to prevent or eliminate disease, to strengthen the defences of the country and guarantee a permanent peace. The broad attainment of these goals demands a well-informed public. Science must be intelligently and accurately explained to the layman so that he may understand its possible contributions and also its limitations in reference to problems of human welfare and that he may actively help and participate in its applications. Towards this end every available means should be mobilised by the state and the public in order that the level of knowledge of the producer might be raised to the highest.

While simple and lucid expositions of scientific subjects and their application to industry and agriculture are growing popular, they are not within effective reach of the unlettered man in India. He could nonetheless be approached through visual education. Even for literates this system has come to be recognised as the most telling and rapid means of enlightenment on a wide variety of subjects. In many countries, Educational Films have become a common and much-appreciated method of broadcasting the progress in science and technology. In Britain itself there are more than thirty Scientific Film Societies, and in America almost every college and university has its Film unit.

The method of learning through films owes its ubiquitous popularity to the fact that man

always thinks in terms of pictures. It is, therefore, far easier for him to comprehend in terms of his "natural language". And it should be admitted that the alphabet is only the second best, and lacks the direct appeal that pictorial presentation offers.

Advances in cinematography promise, further, a potent tool in the understanding of natural phenomena, like plant growth, fertilisation, bird flight, animal movements and certain metabolic process of plants and animals. High speed and micro-motion techniques, through expansion or abridgement of the time factor, have opened up new fields of investigation in fundamental and applied aspects of science. It is thus possible to analyse and get a better insight into the process of germination, flowering, the spread of the flame and the combustion of gases in internal-combustion engines, and stresses in jet turbines blades and other phenomena which cannot be otherwise understood. In industry, time and motion study of factory hands and of technical processes have invariably led to improvements resulting in reduced fatigue to the worker, increased efficiency and larger production.

The utility of films, in education, indeed, holds endless possibilities. In our country, where adult education can contribute so much to agricultural and industrial production, films on mechanised agriculture, soil fertility, plant nutrition, role of trace elements in crop production, application and utility of artificial manures and compost, village sanitation and personal hygiene, and presentation to the factory worker the industry in full perspective and his place in the production of the final commodity will

go a long way in reducing the acute shortage of food and manufactured goods in the country.

The formation of the Scientific Film Society in Bangalore is a step in the right direction for achieving the above-mentioned objectives. The Society has, among its aims and objects, the promotion of interest in scientific films and investigation of the means of application of these for the benefit of human welfare in India, rendering technical assistance to scientists to produce their own films relating to their own researches and to maintain a film library for the use of scientists and the public. The availability of a reasonably cheap film projector and a continuous stream of scientific films within easy reach should make "Home movies" almost as popular as the gramophone and the radio.

That need and scope for such a Society is fully appreciated by our statesmen is seen by the hearty support offered by the Prime Minister of Mysore when he inaugurated the Society. The Ministers both at the Centre and in the Provinces have frequently made it clear that they are alive to the possibilities of the medium of visual (and auditory) education. It should be possible for the Ministry of Education at the Centre to begin with a new section for the production and propaganda of scientific and education films under the guidance of experts. In the meanwhile it is open to the scientists and the public to establish active branches of the Scientific Film Society in every City and help further the cause of Science and Industry in India. And we are confident that this movement will receive the munificent support of the various governments in the country and the co-operation of similar organisations abroad.

## CONTACT RECTIFIER FOR LOW-VOLTAGE HEAVY CURRENTS

AT a time when further development of electrical conversion machinery was considered to have come almost to a standstill, the development of a contact rectifier by Siemens Schuckert, after years of research and operating experience, has focussed the attention of engineers on this new equipment. The American Institute of Electrical Engineers in their summer meeting last year, considered it worth while to discuss this new equipment and examine the possibility of its being used in Electrochemical industries in place of the now well established Mercury Arc Rectifier, especially for low voltage heavy current work.

The new equipment consists of a contact mechanism synchronously driven and adjusted to make metallic contact between the A.C. source and the D.C. load at proper time intervals, i.e., when the particular phase of the A.C. system is capable of delivering energy in the desired direction. These contacts are actuated by a shaft carrying different eccentrics. A feature of this rectifier is the use of saturable reactors with what is termed as "elastic excitation" to obtain good commutation and regulation.

The contact rectifier is a very interesting

development, and the advantages claimed make it particularly suitable for use in electrochemical industry. Overall efficiencies of 97 to 98 per cent., including transformers, have been reported for low voltage operation. Small space requirements, low maintenance costs, absence of auxiliary equipment are some of the distinct advantages mentioned. Reliability of operation is claimed from the operating experience at Hannover. It is stated that during three years of continuous operation the short circuit safety device acted only twice. The contact life was about two months per set of contacts.

From the data available at present, it can be stated that the contact rectifier, with slight improvements in design and further operating experience, might soon make a strong claim for itself in the field of low voltage heavy current operation.

Further information about this rectifier can be gleaned from the following references:

- (1) *British Intelligence Objectives Sub-Committee Report*, No. 408. (H.M. Stationary Office, London.)
- (2) Otto Jensen: *A Mechanical Rectifier Trans. of the Electrochemical Society*, 1946.



## FIFTEEN YEARS OF SULPHA DRUGS—A PERSPECTIVE

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### INTRODUCTION

IT was in 1932 that the method of preparation of prontosil was patented and the therapeutic property also discovered, though this discovery, which "created a sensation and shook the world", was announced by Domagk only in 1935. Since then, a tremendous amount of work has been published with the accumulation of a great deal of knowledge. The lapse of fifteen years has tempered the initial enthusiasm about the efficacy of the drugs, and the new ideas and data have been subjected to critical examination, so that the time is now mature to reckon the advances made in this field. A number of critical reviews have been published dealing with the details of many aspects of the problem. As complementary to these, herein is attempted, without focussing on the details or scanning isolated sections, a perspective of the whole field.

### A NEW ERA IN CHEMOTHERAPY

It is not a mere platitude to reiterate that the discovery of prontosil and the sulpha drugs is an event of epochal importance in the history of chemotherapy. A great discovery distinguishes itself from others not merely by presenting results of immediate importance but by stimulating thought and action in many related fields thus acting as a lever to make great fundamental advances. The discovery and the progress in this field have satisfied these requirements. Ehrlich, as the father of chemotherapy, gets the credit for having recognised and enunciated the quintessence of the problem. In his time, and even subsequently, chemotherapy could not advance in practice beyond a hit-or-miss project. That the subject has been taken up seriously, in spite of this, is an eloquent testimony to its great practical importance and attractiveness even as a commercial venture akin to the extraction of gold from the rocks. There have been very useful discoveries in this field as a result of prodigious effort (such as germanin, plasmoquin, atebirin), but these have not resulted in any great fundamental advances in the field of chemotherapy. For many important questions relating to these drugs, the answers could be no better than guesses, speculations or new obscure phrases. The advent of the sulpha drugs has revolutionised the position. The physiological and bacteriological phenomena relating to chemotherapeutic action have come to be tackled on a chemical, physico-chemical and cytological level, and chemotherapy has, consequently, become the fertile intermixing ground for the physical and biological sciences. This has introduced a new outlook and logic in the subject, and has earned for chemotherapy the status of a science with a rational basis and a rational approach.

### EVOLUTION OF SULPHA DRUGS

The discovery by the French school that the therapeutic property of prontosil is due to

sulphanilamide derived by reduction, simplified the problem and presented it in a clear-cut manner as regards the synthetic side. It did not take long to realise that the free amino-group in sulphanilamide is inextricably connected with the therapeutic activity and that the heterocyclic substituent at the sulphonamide radical actuates the intensity and spread of the spectrum of antibacterial activity, this concept being roughly analogous to the functions of the prosthetic groups and proteins of the enzyme systems. There was, consequently, a lively hunt in laboratories all over the world for all heterocyclic ring systems. The period, 1939 to 1942, was the most fruitful on the synthetic side, when almost all important possibilities were explored and the sequence of sulphapyridine, sulphathiazole, sulphadiazine, sulphamerazine, sulphapyrazine established. The period following which, frankly, is one of disintegration and decay, attracted the second batch of workers from many academic laboratories. Much of this work remains uncorrelated divorced from the biological testing and is, therefore, of little interest either from the chemotherapeutic or the chemical point of view.

Of the thousands of compounds synthesised and passed through the mill, only about a dozen came out as worth considering from the clinical point of view. Caustic comments have been made on this ratio, that the search for drugs in chemotherapy is a costly gamble for luck in the dark. There is justification for this. Because the discoverer of a drug gets a halo in the press and the public and even improves his financial position, the effort spent on the study of the more important fundamental problems connected with the chemotherapeutic action is not as much as that directed towards the discovery of new drugs by blind venture. However, in the present case, there is the consolation that we have gained some important knowledge. As a rough approximation, we can now scent how the chemotherapeutic activity runs through the structural section. As was not appreciated before, this activity transcends the purely organic linkage or radical level, and is governed by molecular geometry and configuration as reflected in the physicochemical properties. As a result of theoretical reasoning, it is concluded that as far as the intrinsic chemotherapeutic activity is concerned, the maximum appears to have been touched in the region, sulphathiazole, sulphadiazine and sulphamerazine. That nothing has been discovered to contradict this conclusion adds a great deal of prestige to this theoretical reasoning. From this point of view, the chemical work is now well high complete and the chances of discovering sulpha drugs with greater intrinsic activity than the above seem to be very remote.

When it comes to the question of using the drug clinically, the way the host deals with and affects the pathways of the drug in the physiological system assumes as much importance as

its intrinsic activity. The sulpha drugs are used for the treatment of a variety of infections wherein its action is required in such diverse sites as the blood stream, tissues, intestines, cerebrospinal fluid, urinary tract, surface of wounds, etc., depending upon the nature of the infection. The drug should reach these sites in sufficient concentrations and also be maintained therein sufficiently long. The properties of the drug responsible for the therapeutic activity will be different from those governing its transport and metabolism in the physiological system. In addition, the acetylation of the drug and its rapid excretion from the system limit the activity and overall clinical result of the sulpha drugs. If these could be controlled, the intrinsic activity of the drug could be capitalised from the clinical point of view.

#### ANIMAL EXPERIMENTS

Two properties of the drug that are of importance from the clinical point of view are: the intrinsic level of chemotherapeutic activity and the degree of toxicity, i.e., the effect of the drug on the parasite and the host respectively. While the first decides the degree of response we can expect from the patient to the drug, the latter governs the degree of safety in administering the drug. Methods of measuring these two properties have now been standardised and rationalised.

Testing the effect of the drugs in experimental streptococcal, pneumococcal, *P. pestis* and other infections in mice (which are convenient to handle and require only small quantities of the drug for the screening experiments) yields clear-cut results. Though the course of the disease in these experimental infections and in human cases (except in the case of *P. pestis*) do not even closely correspond, the results obtained are quite comparable. The results of the animal experiments signify that the drug retains its antibacterial activity within the system of the host (acting as a true chemotherapeutic) and, if given a chance to meet the bacteria, can successfully destroy them. If the testing is done on a strict quantitative basis, the results can be of clinical importance. In the case of the systemic infections. It is the concentration of the drug maintained in the blood and tissues that decides the degree of therapeutic activity; the oral dose as such cannot be used for this comparison, because the blood concentration is a function of the rate of absorption, excretion and metabolism which vary from drug to drug. For accurate estimation of the intrinsic chemotherapeutic activity and also the level of this concentration at which this effect is maximum in experimental infections, the drug-diet method, which ensures definite uniform concentration of the drug in the blood of the experimental animal, is resorted to.

In his anxiety to keep an eye on the therapeutic activity and toxicity of the drugs simultaneously, Ehrlich developed the chemotherapeutic index, and this ratio he took into consideration to grade the compounds in the order of merit for clinical use. Though in this he shifted the locus of emphasis by giving undue consideration to the maximum tolerated dose,

the results were not wide off the mark as far as the arsenicals were concerned. But in the case of the sulpha drugs, the disparity will be very glaring. So long as a drug is absolutely safe in therapeutic doses, the ceiling of toxicity is not at all of importance from the practical point of view. If a *la* Ehrlich we couple chemotherapeutic activity with the maximum tolerated dose to obtain the chemotherapeutic index and use this to grade the compounds with regard to their clinical utility, we stray away from our original aim. So, the determination of the chemotherapeutic index is now given up. When we know that the compounds are not lethal in therapeutic doses, we look in for the minor toxic symptoms produced by the drug. The chronic toxicity of the drugs in repeated doses over an extended period of time is, therefore, estimated.

#### RATIONALISATION OF CLINICAL USE

The clinical value of the sulpha drugs for the treatment of many bacterial infections is now well recognised even by laymen. The extent of its use can be judged by the fact that in 1943, in U.S.A. alone, nearly ten million pounds of this drug were manufactured, an unprecedented record for any chemotherapeutic agent. There are misgivings that penicillin may supersede the sulpha drugs altogether. The mechanisms of action of sulpha drugs and penicillin are different; their antibacterial spectra also differ though they overlap in certain regions. The sulpha drugs, from the point of view of cost, ease of administration, stability, storage, etc., have great advantage over penicillin, and these will decide their infiltration even into the rural areas for clinical use. There is no possibility, therefore, that the sulpha drugs would go out of use.

From 1935 onwards, about two dozen compounds have been tried clinically. If we carefully scrutinise the data, keeping the two cardinal features, cheapness and effectiveness, of the drugs as the guiding principle for selection for clinical use, we arrive at the conclusion that sulphathiazole, sulphadiazine and sulphamerazine are the best of the lot. Of the last two, sulphamerazine is preferable because its rate of excretion is much slower and its acetyl derivative is more soluble than that of sulphadiazine. Sulphamerazine can, therefore, be administered at longer intervals, and the renal damage due to it is much less. Sulphaguanidine, succinylsulphathiazole and phthaloylsulphathiazole are popular as intestinal antiseptics, because their absorption from the intestines is very little. But it appears that the same overall result could be obtained by a judicious use of sulphadiazine or sulphamerazine. As the manufacture of these three drugs are patented, attempts are being made to fabricate all types of products as possible rivals.

The important advance made in the clinical field is in the rationalisation of the therapeutics. Till the advent of the sulpha drugs, the oral dose of the drugs was taken into consideration for clinical trials, and even this dose was arrived at arbitrarily by trial and error. Now, as a rational procedure, emphasis is put on the



blood concentration attained which we know governs the therapeutic effect and of which we have definite information. So the oral dose is adjusted to maintain the optimum concentration of the free drug (5 to 15 mg. per cent. as is required) in the blood. In view of this, we can appreciate the importance of the rate of excretion of the drug from the system from the therapeutic point of view, and this property now requires as much study as the chemotherapeutic activity itself. If the drug can circulate in the system, say for two or three days, the advantages are of a far-reaching nature. The total dose to be administered will be cut down to about a sixth and, consequently, the toxic symptoms will also become negligible.

A chemotherapeutic drug which can be administered orally has great advantages. The treatment becomes very popular, not at all annoying to the patient and also very cheap. But this oral administration has other side consequences if the drugs happen to possess strong bacteriostatic action. In the treatment of systemic infections wherein the drug is required in the blood stream or tissues, by oral administration we make them reach these sites by way of the stomach and the intestines. The intestines are populated by bacteria that supply by their synthesis man's requirements of some vitamins. The sulpha drugs, while they are in the intestines for a number of days, because of repeated administration prior to absorption, kill the intestinal flora and, as a consequence, give rise to symptoms of deficiency of these vitamins. So far, we have found that the vitamins thus involved are vitamin K and folic acid. The above deficiency is particularly noticeable in the case of drugs poorly absorbed from the intestines and so have a greater destructive effect on these bacteria. This side effect should be kept in mind whenever an intensive therapy with the sulpha drugs is undertaken. Advantage has been taken of this phenomenon to study the synthetic abilities of the intestinal flora and the part they play in the vitamin supply of the system.

#### MECHANISM OF ACTION OF SULPHA DRUGS

The unravelling of the mechanism by which the drugs act should not be considered to be of mere academic interest. The discovery of prontosil actually arose out of the wrong concept that those compounds which show activity *in vivo* should be inactive *in vitro*. This is probably derived as a converse of the observation that many compounds that show very good activity *in vitro* are inactive *in vivo* and also partly as a consequence of the lack of understanding of the difference in the mechanism of action of an antiseptic and a chemotherapeutic. Domagk vehemently held the view that the activity of prontosil is due to some action elicited by the drug from the host. As a result of subsequent extensive experiments it emerged that the bacteriostatic action of the sulpha drugs is produced by the same mechanism *in vivo* and *in vitro* by virtue of their inherent property and that they do not call upon the host for any part to play in this. The chemotherapeutic action of the sulpha drugs result from the interference with an enzyme system vital-

ly connected with the proliferation of the bacteria. The inhibition of multiplication, rather than the instantaneous killing, appears in essence to be the mechanism of action of the sulpha drugs. Thus the interest shifted from the immuno-biological to the cytochemical and enzymic field, wherein the problem is capable of being tackled in a rational manner.

The most important advance resulted from the remarkable discovery of the specific reversal of the bacteriostatic effect of the sulpha drugs both *in vivo* and *in vitro* by *p*-aminobenzoic acid. This action is distinctly different from the reversal observed in the case of methionine, purines, peptone, etc. The theory developed by Fildes and Woods conceived *p*-aminobenzoic acid as an essential metabolite of the bacteria, the utilisation of which is prevented by the sulpha drugs by stopping the enzyme system concerned with it from functioning. The sulpha drugs show this property by displacing *p*-aminobenzoic acid from the enzyme system by virtue of the structural similarity of the two compounds concerned. Though this appeared to have solved the problem, a great deal of controversy and many issues were raised as regards *p*-aminobenzoic acid being an essential metabolite and on the mechanism of competitive inhibition. As a result of this, very fruitful work has been done.

It was found that *p*-aminobenzoic acid is a growth factor for *Clostridium acetobutylicum*, *Acetobacter suboxydans* and *Streptobacterium plantarum* and is even classed as a member of the vitamins of the B group. The exact part played by this acid in the life of the bacteria is not exactly known, though it appears to be connected with cell multiplication. We have also not identified the enzyme system involved, though it appears that the acid as such is not a prosthetic group of an enzyme or coenzyme as some conceived it. The discovery of the growth-promoting effect of *p*-aminobenzoylglutamic acid and the presence of this grouping in folic acid are significant pointers. Work in this direction is likely to throw much light on the mechanism of cell division and multiplication of the bacteria.

#### CHEMOTHERAPEUTIC AND ANTISEPTIC ACTION

The mechanism of competitive inhibition has greatly influenced the imagination of the chemotherapeutists, even to the extent of making them blind to other possibilities. This gives an insight into one of the important problems in chemotherapy, *viz.*, difference between the actions of an antiseptic and a true chemotherapeutic agent. A huge number of synthetic reactions, all mediated by specific enzymes, are going on simultaneously within the same cell *in vivo* and in the bacteria. That each one of these reactions can go on as if in isolation, without being interfered by any other, has been made possible by the extreme specificity of the enzyme reactions, *i.e.*, of the substrates and the coenzymes. If the parasite lodged in the system of the host is to be selectively destroyed, this can be achieved by putting out of action one of the enzyme systems which is vital for the bacteria but differs from that of the host. Since the bacteria are versatile in syn-

thetic activities and are equipped to meet all emergencies by adaptation, they should not be capable of developing alternative pathways or other shunts to meet the needs. The true chemotherapeutic agent shows the specific selective action by the above-mentioned mechanism. The antiseptic, on the other hand, not possessing this selective action, when put in a complicated system, gets entangled in the one it comes across first and thus, going astray, is not available where its action is required. This is how the antiseptic which is very active in the test-tube loses its activity *in vivo*.

One of the ways to stop an enzyme system from functioning in a selectively specific way is by the mechanism of competitive inhibition, taking advantage of the structural specificity of the substrate of any other participant in the enzyme system. A compound which is close enough in structure to this to get involved in the first stage but not identical enough to be actually utilised in the enzyme reaction can stop the enzyme system from functioning. If this enzyme system is itself vital or a vital link in an important chain, we have obtained the typical chemotherapeutic effect. If this effect is to be of clinical value, the additional conditions to be satisfied are: (i) the inhibitor should not undergo metabolism or have affinity for other compounds *in vivo* and (ii) the substrate or compound being displaced by the inhibitor should not be produced *in vivo* in sufficient concentrations to nullify the action of the inhibitor itself. Though we are able to chalk out these principles in concrete terms, no great advance has been made in discovering more chemotherapeutics because we do not know enough about the chemistry of the enzyme systems involved in bacterial multiplication and proliferation. Strangely enough, we came to know of the role of *p*-aminobenzoic acid by the reverse process of working with a true chemotherapeutic agent. Thus, the mechanism of action of the chemotherapeutics gives us a clue to the understanding of the chemistry of bacterial multiplication.

Then there is the question as to the exact phase of bacterial growth on which the drug should act to obtain striking chemotherapeutic action—whether it should affect the respiration, metabolic or catabolic reactions, the cell division, etc. This action will decide the nature of the antibacterial effect obtained. The sulpha drugs and penicillin show their effect only when the bacteria are rapidly multiplying and not when they are in the stationary phase. Their effect is not, therefore, observed at once. This

is roughly taken as a bacteriostatic action as differentiated from the bactericidal effect in which the lethal action is immediate. If an immediate chemotherapeutic effect is desired, the action of the drug must be directed against even the stationary phase of bacterial growth. We do not as yet know enough about the bacterial enzyme systems to evolve anything useful in this direction.

#### PHYSICO-CHEMICAL THEORY OF CHEMOTHERAPEUTIC ACTION

The theory of action of the sulpha drugs, by displacing *p*-aminobenzoic acid from an enzyme system by competitive inhibition, has provided a solid base on which to build the physico-chemical theory of the intensity of the chemotherapeutic effect. One fortunate fact helping us in this venture is the structural simplicity of the drugs in which the only variable is the substituent at the sulphonamide radical. So the problem is to find out how this substituent governs the degree of the intrinsic therapeutic activity. Since the mechanism involved is competitive inhibition, the more the sulpha drug resembles *p*-aminobenzoic acid the greater the degree of activity. Though the *p*-aminobenzoic acid ion and the *p*-aminobenzenesulphonate radical resemble each other in geometric configuration, the only distinct feature about the former is the negative charge. So the more negative the sulphone group, the greater the activity of the sulpha-radical. The only way of gauging the negativity of the sulphone group (governed by the attached amino or substituted amino group) is by the acid dissociation constant ( $pK_a$ ) of the drug. The theoretical calculation shows that the maximum activity will be shown by that drug whose  $pK_a$  value is 6.7. On this basis the maximum activity is almost reached in sulphathiazole ( $pK_a=7.12$ ), sulphadiazine ( $pK_a = 6.48$ ) and sulphamerazine ( $pK_a = 7.06$ ). That no drug has so far been discovered which shows greater activity than the above, indicates that the theoretical reasoning is sound. This is the first time in the history of chemotherapy that a physicochemical property of a compound could be used to predict its antibacterial activity. In the light of this, attempts are also being made to treat the problem on a physicochemical basis. As stated before, this has introduced a new outlook and logic in the field of chemotherapy which has earned for it the status of a science.

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#### MEDIUM OF STUDIES IN COLLEGES

IN the Dominion Parliament, on the first of March, Maulana Abul Kalam Azad, Education Minister, said in reply to Seth Govind Das that as far as primary and secondary education was concerned, the Provincial Governments had accepted the principle that the medium of instruction should be the mother-tongue. Every effort was being made to put this into practice.

The Central Advisory Board of Education and the Educational Conference both came to the

conclusion that the change in University education should be by stages, so that the standard of education did not suffer. It was agreed that the change-over should be spread over five years, and in the sixth year all education should be in the Indian language or languages which should be the medium of instruction. The English language would, however, continue to be a second language and a subject for post-graduate studies.

# VARIATION IN THE NORMAL PRESSURE PROFILE IN THE NEIGHBOURHOOD OF SOUTH AMERICA, THE S. W. MONSOON IN INDIA AND THE SUNSPOTS\*

K. S. RAMAMURTI

## INTRODUCTION

THE author<sup>1</sup> has considered the effect of the variations in the distribution of pressure departures over South America on the Indian Monsoon in a paper entitled "An Analysis of the Influence of the South American Pressure on the Indian Monsoon". The normal pressure distribution over the South Atlantic during April and May has a maximum at latitude 30° S. and a minimum at the equator and at latitude 60° S. A curve with the least number of constants to represent these conditions will be

$$P = \bar{P} + R \{ \sin 6 (\phi - 15^\circ) - \bar{S} \} \quad (1)$$

where  $P$  is the pressure in mm,  $\phi$  latitude in degrees,  $R$  an arbitrary constant and  $\bar{P}$  and  $\bar{S}$  are the means of  $P$ 's and the value of  $\sin 6 (\phi - 15^\circ)$  in the given range. It can be seen that  $\bar{S} = 0$  for the range  $0 \leq \phi \leq 60^\circ$ . The author has fitted a similar curve,

$$p = \bar{p} + r \{ \sin 6 (\phi + \epsilon) - \bar{s} \} \quad (2)$$

by the method of least squares to the average departures of pressure in April and May at various latitudes and considered the effect of the changes in  $\bar{p}$ ,  $r$  and  $\epsilon$  from year to year on the monsoon rainfall of the corresponding year in the Peninsula and N.W. India.

The Peninsula consists of Bombay, C.P., Hyderabad and North Madras Coast. N.W. India comprises West U.P., East and North Punjab, Kashmir, N.W.F.P., and Rajputana to which S.W. Punjab has been added because of its geographical position; but as the rainfall in this division is not representative of the rainfall in the remaining subdivisions, half-weightage has been given to it while giving the divisions weights proportional to their areas.

It has been found that  $\bar{p}$  and  $\epsilon$  in equation (2) above have significant relationship with the Indian Monsoon. Their multiple C.C. with the monsoon rains in the Peninsula and N.W. India are 0.36 and 0.59 respectively. It has also been shown that South American pressure, mean of Santiago, Buenos Aires and Cordoba which is being used by the India Meteorological Department to forecast the monsoon rainfall in the Peninsula and N.W. India, combines in itself to an extent the effects of the change in the mean pressure,  $\bar{p}$  and the shift of the pressure pattern,  $\epsilon$ . But  $r$  has practically no relationship with the monsoon rains in India.

The object of this note is to study the influence of the variations in the normal pressure profile during April and May, viz., the variations in the parameters  $P$ ,  $R$  and  $E$  of the curve,

$$P = \bar{P} + R \{ \sin 6 (\phi - E) - \bar{S} \} \quad (3)$$

on the monsoon rains in India. The relationships among the parameters and the sunspots are also studied. The high pressure belt will now have its axis on latitude  $(E + 15)$  degrees and the low pressure area will be at latitudes  $(E - 15)$  and  $(E + 45)$  degrees. It may be seen that the value of  $E$  for the distribution of normal pressure in South America and neighbourhood is 15° S.

## SOURCE OF DATA AND METHOD

The pressure departures at various latitudes used in the previous paper as well as in this note were computed as follows:

Pressure data were available for 19 stations in S. America in the World Weather Records<sup>2</sup> (1927 and 1934). All the stations whose latitudinal positions were near each other were grouped together and the mean departures of these groups were taken to be the pressure departure at their mean latitude corrected to the nearest half a degree.

In any given year, suppose that the pressure at latitude  $\phi$  degrees has a value  $(P + \delta P)$  mm., i.e.,  $\delta P$  is the pressure departure at latitude  $\phi$  degrees, and that this set of changes of pressure at different latitudes necessitated corresponding changes of  $\delta \bar{P}$ ,  $\delta R$  and  $\delta E$  in the parameters of the curve (3), where  $\delta E$  is radian measure. Then,

$$\delta P = \delta \bar{P} + \delta R \sin 6 (\phi - E) - R \cos 6 (\phi - E) \delta E \quad (4)$$

Now substituting  $E = 15^\circ$ , the equation reduces to

$$\delta P = \delta \bar{P} - \delta R \cos 6 \phi - 6 R \delta E \cdot \sin 6 \phi \quad (5)$$

where  $\delta P$  is the pressure departure at latitude  $\phi$  and  $\delta \bar{P}$  is the mean of these departures between latitudes  $0^\circ$  and  $60^\circ$  S. Thus, the corrections to the parameters of the normal curve to represent the pressure distribution in a given year are got by fitting an equation of the type

$$p = \bar{p} + \alpha \cos 6 \phi + \beta \sin 6 \phi \quad (6)$$

to the pressure departures. Then

$$\bar{p} = \delta \bar{P}, \alpha = -\delta R \text{ and } \beta = -6 R \delta E \quad (7)$$

curves of type (6) have been fitted for the departures of pressure at various latitudes during April and May of each year in the paper mentioned above.<sup>1</sup> The values of the parameters are also given in the same paper.

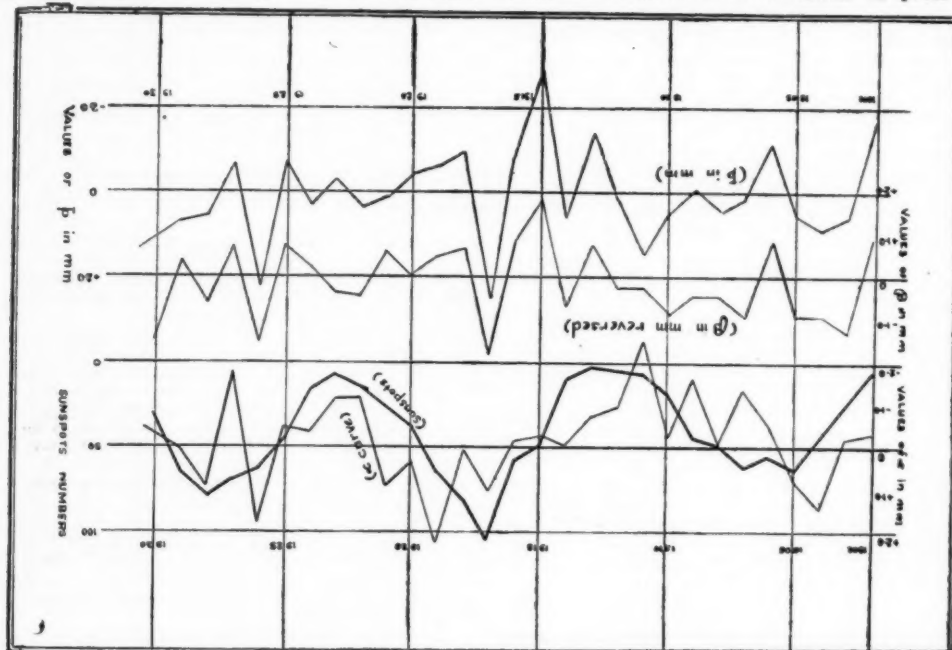
It is evident that  $\bar{p}(\delta \bar{P})$  is a measure of the excess transport of air to the southern hemisphere in the neighbourhood of South America over the normal transport for the season and

\* Read in: the 1948 session of the Indian Science Congress.

$\delta E$  is the shift of the high pressure belt (but not the shift  $\epsilon$  of the superposed pattern as in the previous paper).

To find the effect of the variations in  $\delta \bar{p}$ ,  $\delta R$  and  $\delta E$  on the Southwest Monsoon in India,  $\bar{p}$ ,  $\alpha$  and  $\beta$  were, therefore, correlated with the June to September rainfall in the Peninsula

of pressure does not give any further information about the monsoon than what  $\bar{p}$  gives. But it was shown that  $\epsilon$ , the shift of superposed pattern—that is, the variation in the pattern when the normal distribution of pressure has been taken to be the base line, or again, when the trend in the variation of pressure



and N.W. India and these together with the intercorrelations are given in Table I.

TABLE I

	$\beta$	$\bar{p}$	June to September rainfall in	
			Peninsula	N.W. India
$\alpha$	-0.19	+0.23	+0.11	+0.16
$\beta$		-0.87**	-0.22	-0.31
$\bar{p}$			+0.22	+0.41*

\* Significant at 5% level.

\*\* Significant at 1% level.

## DISCUSSIONS

The multiple C.C. of  $\bar{p}$ ,  $\alpha$  and  $\beta$  with the Peninsula rainfall is 0.24 and with N.W. India rainfall 0.43. Both these values are not very much different from the C.C.'s of  $\bar{p}$  alone with them. The C.C. of  $\bar{p}$  with N.W. India rainfall is significant at 5 per cent. level and that of  $\bar{p}$  with  $\beta$  at 1 per cent. level. The rest of the C.C.'s are not significant.

The above results show that a consideration of the variation in the latitudinal distribution

with latitude has been eliminated—gives additional information on the subsequent monsoon in India.

The above fact is also demonstrated by the Analysis of Variance technique. Let the corrected sum of squares (of 29 years) of N.W. India June to September rainfall be  $s^2$ . The sum of squares due to regression is  $R^2 s^2$  where  $R$  is the simple or multiple C.C. according as one or more independent variables are considered. Tables II(a) and II(b) give the sum of squares due to  $\bar{p}$ ,  $\epsilon$  and  $r$  and due to  $\bar{p}$ ,  $\alpha$  and  $\beta$  respectively.

TABLE II(a)

S.S. due to	D.F.	Sum of squares	Mean square	F
$\bar{p}$	1	0.1681 $s^2$	0.1681 $s^2$	6.57*
$\epsilon$	1	0.1800 $s^2$	0.1800 $s^2$	7.03*
$r$	1	0.0119 $s^2$	0.0119 $s^2$	
Residual	25	0.6400 $s^2$	0.0256 $s^2$	
Total	28	1.0030 $s^2$		



TABLE II(b)

S. S. due to	D.F.	Sum of squares	Mean square	F
$\bar{p}$	1	0.1681 $s^2$	0.1681 $s^2$	5.16*
$\alpha$	1	0.0045 $s^2$	0.0045 $s^2$	
$\beta$	1	0.0123 $s^2$	0.0123 $s^2$	
Residual	25	0.8151 $s^2$	0.0326 $s^2$	
Total	28	1.0000 $s^2$		

\* Significant at 5% level.

Another important point brought out by the C.C.'s (Table I) is the extremely significant negative relationship between  $\bar{p}$  and  $\beta$  and, therefore, the high positive association between  $\bar{p}$  and  $\partial E$ . That is, between  $\bar{p}$  and  $E_p$ . The values of  $\epsilon$  and  $\bar{p}$  have been plotted on a graph. The high order of correspondence between  $-\beta$  and  $\bar{p}$  can be seen from the chart. This means, that the more the import of air into the South Atlantic region the further will the axis of high pressure belt be shifted from the equator. That is, the equatorial cell of the meridional circulation expands longitudinally with advection of air.

SUNSPOTS  $\alpha$ ,  $\beta$  ETC.

The values of  $\alpha$ ,  $-\beta$  and  $\bar{p}$  have been charted on a graph (see chart). The mean annual observed sunspot numbers for the corresponding years as given by Brunner<sup>1</sup> (1939) are also charted along with the  $\alpha$ -curve. It may be seen that the graph of  $\alpha$  follows fairly closely the graph of sunspot numbers. The C.C.'s have

been worked out between the annual mean sunspot numbers and the values of  $\alpha$ ,  $\beta$ ,  $\bar{p}$ ,  $\epsilon$  and  $r$  of the corresponding year. These are tabulated below:

	$\alpha$	$\beta$	$\bar{p}$	$\epsilon$	$r$
C.C. of mean annual sunspot numbers with	+0.44*	-0.12	+0.18	+0.34	+0.22

\* Significant at 5% level.

$\alpha$  has a significant positive correlation with the mean annual sunspot number of the corresponding year. Since  $\alpha = -\partial R$ ,  $R$  the amplitude of the normal pressure profile in the South Atlantic decreases with increasing sunspots. Perhaps this could be explained by a sympathetic circulation induced in the earth's upper atmosphere by the circulations in the sun which are seen as sunspots.

1. Ramamurti, K. S., "An Analysis of the Influence of the South American Pressure on the Indian Monsoon" (to be published by the India Met. Department).
2. World Weather Records, *Smith. Misc. Coll.*, 1927 & 1934, 79, and 90.
3. Snedecor, G. W., *Statistical Methods*, Collegiate Press, Inc., Am. s. Iowa, 1946.
4. Brunner, W., *Terrestrial Magnetism and Atmospheric Electricity*, 1939, 44, 3.

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## SOME DEVELOPMENTS IN FERROUS METALLURGY \*

THAT the world has consumed more metals during the first twenty-five years of this century than in all preceding time strikingly illustrates the predominant position held by metals in modern industrial civilisation. Amongst the metals, iron and steel, by virtue of their versatility, potential supply and low cost of production hold an unrivalled place among industrial materials. Some recent developments in the iron and steel industry, arising from advances in scientific knowledge and technique, leading to the production of more and better steels for general and special purposes have been considered in the address delivered by Mr. N. Sen to the Section of Engineering and Metallurgy at the Indian Science Congress at Patna.

Amongst the more important developments in the production methods of iron and steel and of their products may be cited (1) the adoption, where applicable, of the so-called "acid-burning process", where the use of an acid slag

(lime to silica ratio of about 0.9) considerably diminishes the coke consumption; (2) the use of ore crushed to pieces less than about  $\frac{1}{4}$  inch, which enables the ore to be reduced by carbon monoxide higher up the blast furnace than otherwise and thus leading to increased carbon efficiency; (3) the use of oxygen in the blast furnace and the open hearth to enrich combustion mixture as well as for carbon reduction in the latter (a laboratory development as yet, which promises to find immense application in industry); (4) the use of electromagnetic circulation of the metal in the electric arc furnace by installing specially disposed coils in the hearth of the furnace and thereby increasing the homogeneity and speed of desulphurisation of high alloy steels; (5) the increasing adoption of electric iron smelting and of low temperature hydrogen reduction followed by electric melting of the sponge-iron cake produced in the first instance (a development of particularly great importance in India, because of the high potential resources of hydro-electric power and the restricted reserves of metallurgical coal); (6) the adoption of rolling processes for the production of weldless tubes; and (7) improvements in the casting, forging and allied operations.

\* Extracts of Presidential Address delivered by Mr. N. Sen, to the Section of Engineering and Metallurgy at the 35th Session of the Indian Science Congress at Patna, 1948.

Developments leading to the production of improved quality, and special steels based on increased understanding of the main causes of the chief defects occurring in steels, viz., piping, segregation, inclusions, blowholes, etc., and of the specific characteristics of steel required to meet a specific purpose, have been no less striking than the developments in production technique. Amongst these may be given as examples (1) studies of the law of Mass Action leading to a clearer understanding of slag-metal reactions, and of Ingot design, pouring temperature and technique, resulting in the production of "cleaner" and "sounder" steels; (2) improved methods of inspection and non-destructive testing of cast, welded, forged and otherwise fabricated material by X-ray, supersonic and magnetic testing methods; (3) studies of isothermal transformations, i.e., of the transformation at various constant temperatures of steel, initially in the austenitic condition, and of the hardenability of steel which have made possible the production of heat-treated members of large sections and have also led indirectly to the conservation of valuable alloying elements, as the influence of the latter on

steel has been shown to be more multiplicative than additive; (4) development of permanent magnet and high permeability steels, and application of 'Powder-metallurgy' techniques (pressing and sintering of metal powders) for the production of permanent magnets of small sizes and intricate shapes; (5) development of corrosion-resisting and stainless steels by studies of the thin films formed on their surface by electron-diffraction and other methods and of creep-resisting steels; and (6) development of X-ray crystallography and the mathematical theory of metals, which have led to an understanding of the principles of alloying and of the formation of intermetallic compounds in metals.

In conclusion, it may be said that while metallurgy may have been for long an art, it has become a science only recently. It is at an exciting stage of development, and we can confidently look forward to a period when alloys for specific purposes can be "made to order"; at the same time, the increased knowledge will enable us to utilise better the alloys that we already possess and to conserve those elements, the reserves of which are limited.

E. G. RAMACHANDRAN.

## OUTLINE OF SOME MODERN THEORIES OF STATISTICAL INFERENCE\*

**S**PEAKING on the above subject Mr. S. N. Roy reviewed the recent developments within the last 25 years in the theory of statistical inference as worked out by Fisher, Neyman, Pearson, Wald and other statisticians.

After defining the subject as dealing with "inferences made from a sample of actual observations—either pure random or random under qualifications—about the universe sampled", he started with a set of  $n$  stochastic variables ( $x_1, x_2, \dots, x_n$ ) (sometimes written for shortness as  $[x^{(n)}]$ ) and a similar symbol  $[\theta^{(k)}]$  for parameters  $\theta_1, \theta_2, \dots, \theta_k$  with a probability distribution

$\phi(x_1, x_2, \dots, x_n; \theta_1, \theta_2, \dots, \theta_k) \prod_{i=1}^n dx_i$ , (in the case of continuous variables) or simply  $\phi(x_1, x_2, \dots, x_n, \theta_1, \theta_2, \dots, \theta_k)$  in the case of discrete variables;

The main objectives in the case of any general  $\phi$  are:—

(i) Inference about  $\phi$  covering both its forms and parameters  $\theta^{(k)}$  this inference being made in the light of  $[x^{(n)}]$  of which a special but important case is (a) inference about  $\theta^{(k)}$  assuming  $\phi$  to be a known form, and

(ii) testing again on the basis of  $[x^{(n)}]$  any hypothesis concerning  $\phi$ —both form and  $[\theta^{(k)}]$  of which a special case is (ii) (a) testing any

hypothesis about  $[\theta^{(k)}]$  assuming the form of  $\phi$  to be known."

It was later shown how the Fisher's theory of point estimation and the Neyman and Pearson's theory of testing hypothesis help us in solving these problems. In connection with the latter theory, the parametric cases with simple hypothesis and the parametric cases with composite hypothesis were also discussed.

There can be instances in the parametric cases where the uniformly most powerful tests even in the limited sense do not exist. Even though the most powerful tests with regard to a particular alternative hypothesis and a corresponding confidence interval may exist, it will not answer the question what a particular hypothesis or estimate is worth "vis-a-vis the totality or a suitable sub-totality of other possible alternatives or estimates". The contributions of Dr. Wald towards solving such a question consist in the asymptotically most powerful tests and shortest confidence intervals. The most powerful tests on an average are also indicated.

Dr. Wald's general and unified theory of statistical inference not only broadens the basis of both estimation and testing of hypothesis, but also fuses both into a remarkable synthesis. The speaker gave a short but illuminating picture of this theory and also of his (Dr. Wald's) latest contribution, the technique of sequential analysis.

M. C. SATYANARAYANA,

\* Extracts from the Presidential Address of Mr. S. N. Roy, to the Section on Statistics, at the Indian Science Congress, Patna, 1948.



## MINERAL SPRINGS OF INDIA<sup>\*</sup>

FOR the first time, a comprehensive report on the mineral springs of India in its various aspects has been presented by Dr. P. K. Ghosh from the presidential chair of the Geology Section of the Indian Science Congress. Mineral springs are of considerable importance in European countries; and at the present time, many of the localities where mineral springs have been noted are centres of flourishing commercial enterprises. Many of these localities in Central Europe have become world famous; and water from such localities is bottled and sold in all parts of the globe on account of its reputed medicinal properties.

Unfortunately in India, except for occasional publications that have appeared on and of, no systematic work has been done. Up-to-date information regarding mineral springs is meagre, although the country is known to possess a large number of natural springs.

Though Sir Thomas Holland had pointed out the importance of the study of mineral springs as early as the commencement of this century, yet, not much work was done till 1939, when Dr. Sir Cyril Fox took up the problem for detailed investigation.

A general study of the geology of the springs in India has shown that they are located in groups along certain definite lines, and these lines correspond with directions of major faults in the area. In limestone areas springs occur in the joint planes and solution channels. Springs in valleys generally indicate the local ground-water level. Again a study of the distribution of these springs in India show certain broad belts to which they are confined, and detailed study has shown that these groups of springs are invariably related to major geological changes that have taken place in India. The following classification shows the intimate relationship that exists between springs and geological structure of the country.

1. (a) Mineral springs of Bihar, which are more or less parallel to the coalfield boundaries; (b) mineral springs of Rajgir area; (c) mineral springs of Monghyr area. These are closely related with the east and west post-Gondwana faults.

2. Mineral springs of west coast of India such as of Ratnagiri, Kolaba, Thana and Surat districts of Bombay.

3. Those of Sind and Baluchistan.

Springs belonging to the above two areas are intimately related with the meridional dislocations during the tertiary period.

4. The mineral springs associated with the Himalayan belt. These are due to local orogenic causes. These conclusions have been

further strengthened by the discovery of zones of crushing and brecciation near sites of mineral springs.

The chemical composition of the spring waters varies according to the nature of the country rock through which it flows. Those found in Archæan terranes are fairly highly radio-emanative and of low mineral content. Those emerging from the basaltic regions are low in radium emanations, but are rich in alkaline earths, sulphate and chloride radicals. Springs emanating from limestone areas are rich in calcium, bicarbonate, carbonate and sulphate radicals.

There are different kinds of springs, some are cold, others are luke-warm and still others are boiling hot. The temperature of these springs have always been constant. The flow of water is generally large during the rains, and meagre during summer. The hot springs do not show much variation. Majority of the cold water springs draw their source of water from the surface collections, but hot water springs are supposed to draw their supply from deeper regions.

Mineral spring waters may be either temporarily or permanently radio-active. The Indian waters investigated are only temporarily radio-active, and this is due to the presence of radon in solution in microscopic quantities derived from the disintegration of radio-active minerals in rocks.

Many of the spring waters are charged with soluble salts in fairly large proportions, and the chief of them are sulphates of magnesium and sodium, bicarbonates and chlorides of alkalies and alkaline earths. Some of them also contain iodides and bromides, and consequently many of them are credited with therapeutic values. A fairly large number of Indian spring waters compare very favourably with foreign waters in composition. The analyses of a large number of Indian spring waters can be grouped as follows.

- (1) Simple waters of low mineral contents.
- (2) Alkaline waters characterised by soda and bicarbonate radicals.
- (3) Sulphur waters charged with  $H_2S$  and sulphide and sulphate radicals.
- (4) Chloride or saline water.

In the concluding portion of his address, Dr. P. K. Ghosh has tried to speculate on the source of heat for the hot water springs of India. In so far as these springs of C.P. and Bihar are concerned, he has made the suggestion that the juvenile waters associated with the latest phase of the igneous activity, namely, the Deccan trap, may be the possible source. Though other alternatives are considered, it is presumed that the main source of the heat must be the juvenile waters associated in such large quantities with the magma chambers in the deeper portions of the Earth.

M. R. SRINIVASA RAO,

<sup>\*</sup> Presidential Address of Dr. P. K. Ghosh to the Geology Section of the Indian Science Congress, Patna, 1948.

## SEXUAL PERIODICITY IN INDIAN BIRDS\*

PROFESSOR A. B. MISRA of the Hindu University, Benares, has chosen for his presidential address to the Zoology Section of the Indian Science Congress, a most fascinating subject, a subject in which he has been a pioneer worker in India. He has been engaged in the study of the sexual periodicity among Indian birds for the last twelve years and has investigated no less than twelve species. The results of the author have abundantly shown that the accepted views about sexual cycle are not applicable to all the members of the avifauna in all climes.

The male reproductive glands of the common Mynah (*Acridotheres*) show maximum size in May-June and afterwards there is a decline. Microscopic examination also shows that during May-June, the sperma-telesiosis is in full swing. A very important phenomenon has been noticed during these progressive changes in the testes of the birds examined at Benares. A large number of cells appear suddenly in the tunica vasculosa and transgress not only into the intertubular areas where they behave like interstitial cells, but also into the tubules to transform themselves into sperms. Then, during the downward phase of the cycle an elimination of some 'weak and incompetent cells' takes place within the tubules. Thus, there is not only an annual reinforcement of extraneous cells into the tubules for the manufactory of sperms but also an elimination process. The interstitial cells become prominent after the spermatogenic wave.

While the majority of birds conform in their sexual periodicity to a general plan, birds like *Tyto* and *Bubo*, however, reach their reproductive climax during October and December respectively. Naturally this leads us to question why there should be such seasonal differences.

\* Abstract of Prof. A. B. Misra's Presidential Address before the Zoology Section of the Indian Science Congress, 35th Session, Patna, 1948.

It has been pointed out that environmental factors like light, ultraviolet radiation, temperature, rain and food may be potent causes. But in a country like India which is abundantly endowed with this source of energy all through the year, light may not be so important; even with regard to the effect of actinic rays, the two exceptions mentioned above preclude us from accepting it as a causal factor; similarly temperature may be playing only a secondary role. While food is essential for maintaining proper health, it has been argued that it cannot be regarded as a conditioning factor, thereby differing from the observations of Baker and Marshall.

While some birds are profoundly affected by the environmental influences, internal rhythm predominates in others. Baker's correlation between internal rhythm and ecology become questionable when applied to vertebrates like mammals, and, therefore, it is 'idle to speculate on the nature of the sexual rhythm or its relationship with the environment'.

The beak colour as influenced by the endocrine secretions has been noticed in a few Indian birds like Cattle Egret, Water-hen, etc.

With regard to the important question of mitosis, it is noticed to take place all through the day, unlike in the English sparrow in which it occurs only during the early hours of the morning. Amitosis and abnormal sperms are not uncommon.

Finally, it has been pointed out that a complex of multiple physiological factors like the genetic control of the endocrine glands, the activation of the gonads, susceptibility of the soma to the endocrine influences, selective responsiveness of the organism to the external environmental factors and the accumulated effect of the environment upon the organism seem to be instrumental in governing the sexual cycle in birds, and many, if not all, of these require further elucidation.

L. S. R.

## COSMIC RAY CONFERENCE

A CONFERENCE on Cosmic Rays was held, October 6 to 11, 1947, in Cracow, Poland.

More than 15 papers were read during the 9 sessions, one of which was held 100 meters underground, at the salt mines of Wieliczka. The discussions following each session were not limited in time in order to permit full exchange of ideas and information.

Besides the general conference, two special sessions of the Cosmic Ray Commission of the International Union of Physics were held to discuss special problems of interest in the field of cosmic radiation.

Several resolutions were passed. One looked toward a conference of the Commission to be held in Europe in the period July 1 to September 7, 1949. A second, given in full below, dealt with names for the elementary particles. A third authorized the preparation and publication of a small pamphlet to list men and laboratories all over the world concerned with problems of cosmic-ray physics. It was arranged that any suggestions made in this latter connection should be sent to Prof. Pierre Auger in Paris.

Among the subjects discussed during the

Conference were the new discoveries of Dr. Powell, of Bristol, of two types of mesons; the theoretical interpretation of experiments on Cosmic Rays, by Dr. Heitler and Dr. Wheeler; the extensive atmospheric showers (Auger showers), the penetrating showers, and the nature of cosmic-ray particles.

Resolution on Names for the Elementary  
Particles

The Cosmic Ray Commission of the International Union of Physics at its meeting in Cracow (October 9, 1947):

- (1) Recognizes the convenience of uniform names for the elementary particles.
- (2) Recognizes that it may be undesirable to make an official recommendation on name in any particular case until widespread usage justifies such a recommendation.
- (3) Notes that the term *nucleon* has found quite general recognition as a common term to denote both neutrons and proton.
- (4) Recommends, therefore, that the term *nucleon* receive official recognition for this purpose.

## LETTERS TO THE EDITOR

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### POSSIBLE USE OF FREQUENCY CURVES IN THE CLASSIFICATION OF GYROGONITES\*

A SMALL collection of about 200 Gyrogonites separated out from the Intertrappean cherts collected by Prof. C. Mahadevan from Chittampalle near Vicarabad in Hyderabad State, was divided on the basis of general shape into 7 groups of which 4 had the following numbers: Group 1—33, Group 2—58, Group 3—28, Group 4—40.

The variation in length in each of the above groups was plotted against frequency and the curves yielded the following data:—

	Smallest length	Greatest length	Mode or modes
Group 1 ..	480 $\mu$	720 $\mu$	590 $\mu$
Group 2 ..	420 $\mu$	720 $\mu$	565 $\mu$
Group 3 ..	480 $\mu$	960 $\mu$	620 $\mu$ & 850 $\mu$
Group 4 ..	540 $\mu$	780 $\mu$	540 $\mu$ (?) & 720 $\mu$

Harris<sup>1</sup> has given the curve for variation in length of the fructifications of *Chara vulgaris*, it is a normal curve. The curves for the first two groups are normal and might reasonably be supposed to belong to one species each. Group 3 shows two maxima at 630  $\mu$  and 850  $\mu$ . It appears to be logical to infer that each mode stands for one species. In Group 4, however, there being no specimen shorter than 540  $\mu$ , 540 cannot be taken as a mode but 720  $\mu$  is a mode value and from the curve it is clear that if 540  $\mu$  does not represent the mode, there ought to be one, smaller than that. However, this remains to be applied to a large and varied collection of *Gyrogonites*, and the result studied.

My thanks are due to Professor C. Mahadevan of Andhra University under whose direction the

work was carried out, to Mr. Syed Kazim, Director of Mines and Geological Survey, Hyderabad (Deccan), for permission to work on the materials, and Dr. J. Venkateswarlu, Botany Department, Andhra University, for his suggestions.

Geological Survey Dept.,  
Hyderabad (Dn.),  
January 3, 1948.

S. R. SARMA.

I. Harris, T. M., *British Purbeck Charophyta*, 1930

\* Contribution from the Geology Department of the Andhra University.

### PRESENCE OF GALLIUM IN MICAS AND SCHISTS

It is generally known that gallium is present in very small amounts in certain minerals, chiefly zinc blende, which forms one of the richest sources for this element. It is also present in certain iron ores and in almost all the ores of aluminium. But in these ores it occurs more or less as a trace element and can be detected only by spectroscopic methods. Under these circumstances the following observations on the spectroscopic analysis of certain miccas and schists will be of some interest.

In the Nagpur district there are the Kandri and the Mansar mines well known for their rich manganese deposits. The manganese ores consist typically of "mixtures of bauxite and psilomelane, and occur as bands of considerable length intercalated between gneisses, schists, etc." These schists were examined spectroscopically for their composition, with special reference to the presence of trace elements. A five-foot concave grating was used for taking the spectra. The instrument gave a dispersion of about 11  $\text{\AA}^\circ$  per mm. at  $\lambda$ -4200, in the first order.

The following is the list of the very prominent lines in the spectrum taken with pure carbon electrodes. The lines due to impurities in the electrodes have been omitted.

Wave-length	Int.	Origin	Wave-length	Int.	Origin	Wave-length	Int.	Origin
5535.5	100	Ba I	4289.7	6		3968.5	8	Ca II
			4274.8	8	Cr I	3961.5	30	Al I
5183.6	20		4254.3	8		3944.0	30	Al I
5172.7	10	Mg				3933.7	8	Ca II
5167.3	10		4226.7	30	Ca I			
			4215.5	6	Sr II	3838.3	10	
5014.3	6					3832.3	8	Mg
5007.2	6		4172.1	6	Ga	3829.4	4	
4999.5	6	Ti						
4991.1	6		4077.7	6	Sr II	3653.5	4	
4981.7	6		4047.2	8	K	3642.7	4	Ti
			4044.2	8	K	3635.5	3	
4934.1	10	Ba II						
4607.3	10	Sr I	4034.4	6		3593.5	6	Cr I
4554.0	20	Ba II	4033.0	8	Mn	3578.7	6	Cr I
			4030.7	8				
4434.9	5					3273.9	10	Cu I
4318.6	4	Ca I	3998.6	6		3247.6	10	Cu I
4302.5	6		3989.8	6	Ti			
			3981.8	6		3096.9	2	Mg I
4301.1	3	Ti						
4300.6	3	Ti				3092.8	10	Al I
						3082.2	10	Al I

It will be seen from the above table of wave-lengths that, besides the common elements known to be present in the basic rocks and schists, the specimen under investigation shows the strong line, characteristic of gallium. The prominent lines of gallium as given in the wave-length tables published by the Massachusetts Institute are as follows:—

4172.056 Int. (Arc) 2000 R    2943.637 Int. (Arc) 10  
4032.982    „    „    1000 R    2874.244    „    „    10

Kayser's wavelength tables give the following sensitive lines for gallium:

4172.05 10 R    2943.64 2  
4033.01 10 R    2874.24 2

The pair in the ultra-violet is too faint to be obtained on the plate. The line at 4033 coincides almost with the central line in the Mn triplet which is one of the "Raies Ultimes" of manganese.

Several specimens of mica, including one obtained from Korhadi (a few miles from Nagpur) were examined. They all showed the unmistakable presence of the gallium line, the intensity of which depended on the specimen studied. But amongst the specimens investigated, by far the greatest intensity of the line was observed in the bauxite ores of the Central Provinces. It is very doubtful if the extraction of the element from these ores will be a possibility. At least it will be possible to ex-

tract a greater concentration for spectroscopic study and confirmation.

As the identification of the element depended practically on the single line at 4172, the experiments were repeated using spectroscopically pure copper electrodes and specimens of very clear mica, assumed free from Mn. Though the Mn triplet was considerably reduced in intensity, yet it could not altogether be eliminated. However, it was significant that in some plates the intensity of the middle component was more than that of the outer components of the triplet.

As a result of a large number of measurements on different plates the mean wavelength of the gallium line was found to be  $4172.07 \pm .03 \text{ \AA}$ .

Mahakoshal Mahavidyalaya,  
Jubbulpore.  
February 4, 1948.

A. S. GANESAN.

#### THE USE OF SODIUM CHLORIDE IN THE DETERMINATION OF ACID VALUES OF CELLULOSIC MATERIALS

NEALE and Stringfellow<sup>1</sup> suggested the use of aqueous sodium chloride in the determination of acid values of cellulosic fibres; they added an excess of N/50 caustic soda and titrated back the alkali with N/50 sulphuric acid in presence of bromocresol purple. Hiller and Pacsu<sup>2</sup> consider the presence of sodium chloride unnecessary when phenolphthalein is used as indicator. In the case of jute fibre, however, it has been observed that the amount of excess alkali must be very small, abnormally high values being otherwise obtained.<sup>3</sup> It was found that direct titration of the fibre (previously freed from cationic ash) suspended in sodium chloride solution with caustic soda in presence of bromothymol blue was the best procedure. Sodium chloride of analytical reagent quality in boiled-out distilled water gives a solution neutral to B.D.H. universal indicator. This was employed in all of our experiments. Direct titration of jute fibre in carbon dioxide-free distilled water with dilute caustic soda in presence of phenolphthalein (no excess alkali being added) is rather tedious; the acid is neutralised very slowly towards the end. With sodium chloride, no such difficulty arises; the best indicator being bromothymol blue (or phenol red), for we are in this case actually titrating a strong acid (HCl) with very dilute (N/50) caustic soda. Due to its higher pH range for colour change, phenolphthalein is unsuitable, a higher value being obtained in its presence. The following table will show that there is fairly close agreement between the results with and without sodium chloride in presence of bromothymol blue and phenolphthalein respectively. The former is unsuitable as indicator for weak acids like cellulosic or uronic acids (due to its lower pH range for change of colour); lower acid values are thus obtained.



TABLE I

Acid value of Jute Fibres with different indicators and with and without NaCl

Material	Acid value			
	phenolphthalein		bromothymol blue	
	with NaCl	without NaCl	with NaCl	without NaCl
Defatted jute treated with N/10 HCl and washed neutral	12.4	11.2	11.7	8.9
Defatted jute treated with 1% NaOH at room temp. and then with N/10 HCl and washed neutral	25.8	23.0	23.4	18.1
Chlorite holocellulose from defatted jute	24.6	21.5	22.1	17.8

Acid values obtained with silver ortho-nitrophenolate or potassium iodide and iodate, it may be noted, agree well with those in column four.<sup>3</sup>

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A. K. MAZUMDAR.  
K. B. PAL.

Tech. Res. Laboratories,  
Indian Central Jute Committee,  
Regent Park, Tollygunge,  
Calcutta,  
December 5, 1947.

1. Neale and Stringfellow, *Trans. Faraday Soc.*, 1937, **33**, 881. 2. Hiller and Pacsu, *Text. Res. J.*, 1946, **16**, 390. 3. Sarkar, Chatterjee and Mazumdar *J. Text. Inst.*, 1947, **38**, T. 318.

## ORGANO ARSENICALS-

## Aryl Sulphonyl Esters of Hydroxyphenyl Arsonic Acids

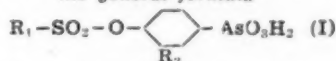
In view of the therapeutic importance of Organo Arsenicals, systematic investigations on the synthesis of new arsenicals for pharmacological studies have been in progress in our Laboratories.<sup>1</sup> A survey of the literature showed that very little study has been made of the aryl sulphonyl esters of hydroxyphenyl arsonic acids, one instance being the preparation of *p*-toluene sulphonyl ester of 3-nitro-4-hydroxyphenyl arsonic acid by Benda and Berthelm.<sup>2</sup>

Eighteen sulphonyl esters (vide table below) of the general formula (I) have been prepared by the action of benzene-, *p*-toluene-, *p*-chlorophenyl-, *p*-acetaminophenyl- and  $\beta$ -naphtha-

lene-sulphonyl chlorides on 4-hydroxy-, 3-nitro-4-hydroxy- and 3-acetamino-4-hydroxyphenyl arsonic acids and characterised. The reactions were conducted in sodium carbonate solution either at ordinary temperature or at 80° C., the products isolated by acidification and purified by crystallisation from organic solvents. Compounds 2, 6, 10, 13, 14 and 18 were prepared by hydrolysing the corresponding acetamino products with acid. Long after our work was completed, Fox<sup>3</sup> has recently reported the preparation of 3-amino-4-[(*p*-acetamino)- and and (*p*-amino)-benzenesulphonyl-oxy] phenyl arsonic acids.

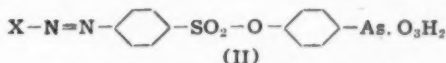
TABLE I

Melting points of the synthesised compounds of the general formula



	R <sub>1</sub>	R <sub>2</sub>	M.P. °C
1	C <sub>6</sub> H <sub>5</sub>	H	170-72
2	"	NH <sub>2</sub>	195-97
3	"	NHAc	190-93
4	<i>p</i> -CH <sub>3</sub> -C <sub>6</sub> H <sub>4</sub>	H	265-7 (d)
5	"	NHAc	203-5 (d)
6	"	NH <sub>2</sub>	180-90 (d)
7	<i>p</i> -Cl-C <sub>6</sub> H <sub>4</sub>	H	above 280
8	"	NO <sub>2</sub>	255-57 (d)
9	"	NHAc	180-85
10	"	NH <sub>2</sub> , HCl	242-43 (d)
11	<i>p</i> -NHAcC <sub>6</sub> H <sub>4</sub>	H	Not sharp
12	"	NO <sub>2</sub>	188-89 (d)
13	<i>p</i> -NH <sub>2</sub> C <sub>6</sub> H <sub>4</sub>	H	170-81
14	"	NO <sub>2</sub> , HCl	267-69 (d)
15	<i>p</i> -C <sub>10</sub> H <sub>7</sub>	H	278-80 (d)
16	"	NO <sub>2</sub>	258-59 (d) with previous shrinking
17	"	NHAc	203-5 (d)
18	"	NH <sub>2</sub> HCl	139-40 (d)

With a view to studying the pharmacological properties, a few arsenical azo dyes, of type (II), have been prepared from *p*-amino-benzene sulphonyl-oxy-phenyl arsonic acid (13).



X = hydroxy or amino-aryl residue.

Full details will be published elsewhere.

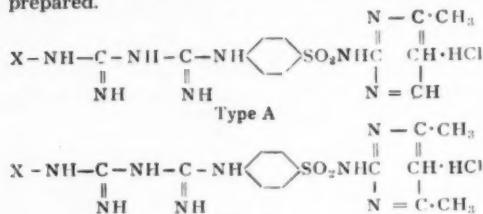
Organic Chemistry Labs.,  
Indian Institute of Science,  
Bangalore,  
February 20, 1948.

A. C. ROY.  
B. H. IYER.  
P. C. GUHA.

1. Krishnan, P. P., Iyer, B. H., and Guha, P. C., *Indian Chem. Soc.*, 1947, **24**, 285, 789, 565. 2. Benda L., and Berthelm, A., *Ber.*, 1911, **44**, 3147. 3. Fox, H. H., *J. Org. Chem.*, 1947, **12**, 872.

### STUDIES IN ANTIMALARIALS SULPHABIGUANIDE DERIVATIVES

As a part of the systematic investigations<sup>1,2,3</sup> on substituted biguanides as possible antimalarials, we have previously reported<sup>2</sup> one compound each of type A and type B (where X = *p*-chlorophenyl). Sixteen more compounds (eight each of the type A and B, vide table) having different aryl substituents at N<sup>1</sup>-position of the biguanide residue have now been prepared.



X = Substitute aryls.

TABLE  
Some sulphabiguanide derivatives

X	Type A, M.P. °C.	Type B, M.P. °C.
1 Phenyl ..	194	222
2 <i>p</i> -Chlorophenyl <sup>2</sup> ..	238	225
3 2:4-Dichlorophenyl ..	220	223
4 <i>p</i> -Bromophenyl ..	231	232
5 <i>p</i> -Iodophenyl ..	227 (slight decomp.)	232 (slight decomp.)
6 <i>p</i> -Methylphenyl ..	231	238
7 3:4-Dimethylphenyl ..	220	219
8 <i>p</i> -Methoxyphenyl ..	200	231
9 <i>p</i> -Nitrophenyl ..	230 (slight decomp.)	257

The hydrochlorides of the sulphabiguanide derivatives of types A and B have been obtained by refluxing the appropriate arylcyanoguanidine with sulphamerazine hydrochloride and sulphamethazine hydrochloride respectively in 90 per cent. ethanol for 6-8 hours. All these compounds are white amorphous powders.

Considering that the formation of metallic complexes (chelates) by the biguanide structure of paludrine may be a possible mode of its action,<sup>4</sup> it was thought of interest to see the chelating capacity of these type of compounds. In an attempt to prepare copper chelates by Andreasch's method<sup>5</sup> it was observed that the sulphabiguanides, reported previously<sup>2</sup> as well as in the present note, show a very feeble tendency towards chelation, which is perhaps due to the electro-negative nature of the substituents. A feeble tendency towards chelation need not necessarily mean reduced antimalarial activity because it has been observed that some of the sulphabiguanides reported earlier,<sup>2</sup> although now shown to possess very little tendency for chelation, exhibited anti-malarial activity. Possibly their anti-malarial activity does not depend so much upon

their capacity for chelation as on the nature of the substituents at the two ends of the biguanide molecules.

Details of this work will be published elsewhere.

We wish to thank the Indian Research Fund Association for the award of a Fellowship to one of us (H. L. Bami).

Organic Chemistry Labs.,  
Indian Institute of Science,  
Bangalore,  
March 4, 1948.

H. L. BAMBI,  
B. H. IYER,  
P. C. GUHA.

1. Bami, H. L., Iyer, B. H., Guha, P. C., *J. Indian Inst. Sci.*, 1947, **29A**, 15. cf. *Curr. Sci.* 1947, **16**, 252.
2. *Indem.*, *Curr. Sci.* 1947, **17**, 386. 3. *Indem.*, "Some N<sup>1</sup>-aryl-N<sup>5</sup>-metachloridino-biguanides" (unpublished work).
4. Card, F. H. S., Rose, F. L., *Nature*, 1946, **158**, 707.
5. Andreasch, R., *Monatsh.*, 1927, **48**, 147.

### INFLUENCE OF GRADED DOSES OF NITROGEN ON THE QUALITY OF CANE JUICE AND JAGGERY RECOVERY

STUDIES on the optimum nitrogen requirement of sugarcane in respect of juice quality and jaggery recovery are recorded in this note.

Experiments during 1944-47 envisaged the application of organic nitrogen in the form of groundnut-cake in six equally spaced doses of 50 lbs. of nitrogen in the range of 0 to 250 lbs. per acre independently and in combination with 10 tons of farm-yard manure, applied as a basal dressing. The nitrogen was applied for each treatment in two equal parts, one at the time of planting (March) and the remainder at the time of trenching and earthing up (June). The layout of the experiment was one of a split plot design, where farm-yard manure and no farm-yard manure constituted the major treatments and six doses of nitrogen, the minor treatments.

A periodical analysis of cane-juice relating to each treatment was made from January to March in all the 3 years. The percentage jaggery recovery was studied by trial boilings of the cane juice. Results of these trials showed that:

(i) A progressive decrease in brix, sucrose and purity, and an increase in the glucose occur with an increasing dose of nitrogen.

(ii) A decrease in the quality of the juice with an increased dose of nitrogen occurs as reflected by the jaggery recovery, which showed a similar fall as the dose of nitrogen increased.

(iii) The effect of farm-yard manure (applied as a basal dressing) on juice quality was not consistent. In a majority of cases the series without farm-yard manure registered more sucrose and purity than that with the farm-yard manure.

(iv) The juice from all treatments attained higher percentages of sucrose and purity and also in jaggery recovery during the year 1944-45 than those in 1945-46. This may be attributed to the reason that the crop was grown in wet lands in the first year and on garden lands in the second year, and this behaviour is in line with the experience recorded on this research station. This also explains why the influence of higher



doses of nitrogen on juice quality and jaggery recovery is less marked in 1945-46.

Studies at this station show that 100 lbs. of nitrogen, as groundnut-cake, is the optimum from the point of both yield and cost of production per unit weight of cane and jaggery. A detailed communication on the subject, embracing all aspects of germination, growth, juice quality, yield of cane and jaggery and economics of manuring will separately be published. Sugarcane Research Station, Anakapalli, M. LAKSHMIKANTAM.  
December 25, 1947. A. SANKARAM.

#### THE PERSISTENCE OF YOLK-SAC IN BABY CHICKS DUE TO ESTROGEN TREATMENT

In the chick the yolk-sac slips into the body cavity on the 10th day of embryonic life by a complex process. It is eventually absorbed with great rapidity and, as a result, the weight of the yolk-sac which is 5.34 gm. at the 12th hour after hatching is reduced to 0.05 gm. on the 6th day of post-hatching life.<sup>1</sup> Byerly<sup>2</sup> observed that the yolk-sac grows steadily from the first day of its formation to reach a maximum weight of about 3.5 gm. on the 15th day of incubation, after which the weight falls to approximately 2.5 gm. at hatching.

In course of an experiment on the responses of the oviduct of sexually immature female chicks to diethylstilbestrol<sup>3</sup> it was observed that in some hormone-treated baby chicks the yolk-sac was persistent. In uninjected controls, however, the yolk-sac was absent. The relevant data is presented in Table I:

TABLE I  
The weight of the persistent yolk-sac in baby chicks

Dosage	No. of birds	Age (days)		Average weight of the yolk-sac (gm.)
		Initial	Autopsy	
Mgm.				
Uninjected ..	3	1	11	No yolk-sac
1 daily ..	3	1	11	1.3
2 daily ..	3	1	11	2.1
Uninjected ..	2	5	15	No yolk-sac
1.5 daily ..	2	5	15	1.0
2 daily ..	3	5	15	2.5
Uninjected ..	3	10	31	No yolk-sac
1.2 daily ..	3	10	31	2.1
2 daily ..	3	10	31	3.1

The table indicates that the level of hormone was a more important factor in determining the state of persistence of the yolk-sac rather than the age of the chicks or the duration of treatment. Thus in a particular age-group the chicks treated with higher dosage of estrogen exhibited heavier yolk-sac than those injected with lower dosage.

It is well known that in estrogen therapy undesirable gastro-intestinal reactions follow the use of diethylstilbestrol in large doses<sup>4</sup>. Possibly, in the present study, the dosage of this estrogen used proved to be too high for

the baby chicks which exerted a harmful influence over the gastro-intestinal tract. Since the yolk-sac is intimately connected to the intestine it is not unlikely that this harmful influence was also extended over the yolk-sac and, as a result, the rate of absorption of yolk was considerably slowed down.

The present investigation was carried out at the Institute of Animal Genetics, University of Edinburgh, Scotland.

Thanks are due to Dr. J. G. Carr for valuable help.

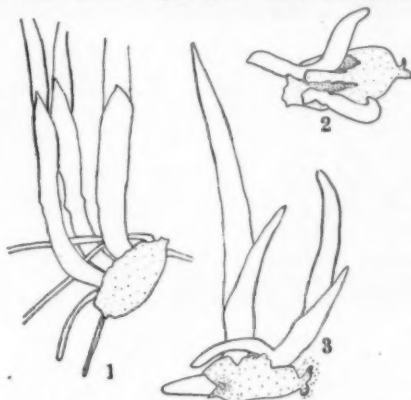
Department of Zoology, AMIYA B. KAR.  
University of Calcutta,  
and Department of Biology,  
St. Xavier's College, Calcutta,  
February 17, 1948.

1. Lillie, F. R., *The Development of the Chick*, New York, 1927. 2. Byerly, F. C., *J. Exp. Biol.*, 1932, 9, 15. 3. Kar, A. B., *Poultry Science*, 1947, 26, 352. 4. Grollman, A., *Essentials of Endocrinology*, Philadelphia, 1942.

#### POLYEMBRYONY IN *DICHANTHIUM ANNULATUM* STAFF.

POLYEMBRYONY as observed by the writer in *Dichanthium annulatum* while studying the autecology of the common grass is reported in the following note.

About 1,500 seeds were germinated under different cultural operations and, out of these



one triplet and about a dozen twins emerged. The triplet came out of a seed treated with concentrated sulphuric acid preceding germination under water (Fig. 1). The twins, however, were observed in seeds germinating in sand and  $\text{KNO}_3$  culture solution. Figs. 2 and 3 show the successive stages of development of the twins from  $\text{KNO}_3$  solution.

A complete account of the germination capacity of the seeds and the cytogenetic study of the polyembryonic cases in *D. annulatum* will be published later.

Department of Botany,  
Benares Hindu University,  
January 12, 1948.

K. C. MISRA.

### A REVERSE MUTATION IN YEAST INDUCED BY ULTRAVIOLET IRRADIATION

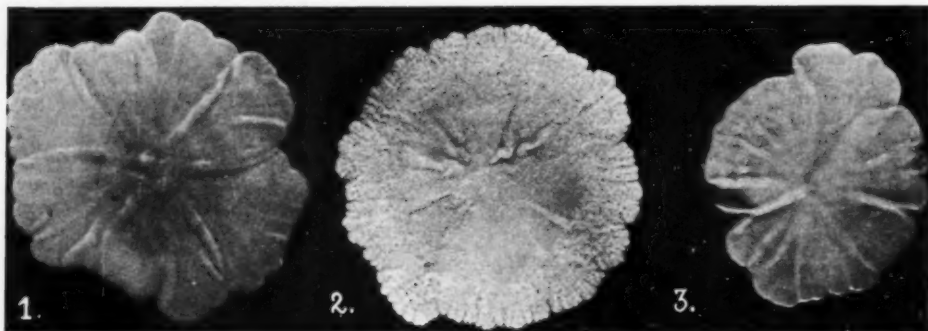
INDISPUTABLE evidence for the identification of simple gene mutations in yeasts is not available in published literature.<sup>1,2,3</sup> The demonstration of tetraploidy<sup>4</sup> and chromosomal translocations<sup>5,6</sup> rendered necessary a clear distinction between chromosomal and gene mutations in yeasts. Definite identification of gene mutations would be possible only if reverse mutations could be demonstrated.<sup>7</sup>

As in bacteria, dissociative changes have been recorded in yeasts also.<sup>8,9</sup> It has recently been

as to eliminate the smooth type altogether from the cultures.

An attempt was, therefore, made to obtain a reverse mutation by exposure to ultra-violet irradiation. Transparent silica tubes containing actively multiplying cells were exposed to a mercury arc for 4 hours at a distance of 90 cms. Twenty-four hours after exposure, the material was plated and nine colonies were picked out from the plates. One of these, BYU 1, gave a smooth giant colony (Photo 3) resembling the first colony of the control.

Curiously enough, a spontaneous reversion of the rough to the smooth type was also observed in the months of September-October 1947,



suggested<sup>10</sup> that mutations in bacteria are spontaneous, discontinuous and uninfluenced by the environment, that the establishment of these mutants and hence the changes in the characteristics of the cultures are determined by their growth-rate and viability and that the environment has a selective influence in that it controls the growth-rate as well as viability. Are the so-called dissociative changes in yeasts the result of gene mutations?

During the past 18 months a continuous but overlapping series of giant colonies of our two chromosome<sup>11</sup> control strain of brewery yeast, BY 1, have been under close observation. Photo 1 shows the appearance of the first colony of the control in September 1946. It had a wavy margin and radial folds on its surface. There was a sudden change in the characteristics of the colony in the month of April 1947. Its appearance is illustrated in Photo 2. The central region of the colony was smooth with sparse minute granulations and the outer half had a rough texture owing to the presence of minute powdery granulations on a lace-like sculpturing. The change was sudden and the smooth type entirely disappeared from the cultures. No colony was obtained in March-April showing both the types as sectors. As cytological investigations indicated no change in the chromosome constitution<sup>12</sup> it was assumed that the change was due to a gene mutation. Since the strain was kept in an active vegetative condition at room temperature, it was believed that the rough type had particular selection value at the summer temperatures

confirming the belief that the nature of sculpturing of the colony is determined by the alleles at a particular locus.

M. K. SUBRAMANIAM.

S. N. KRISHNA MURTHY.

Dept. of General Chemistry,  
Indian Institute of Science,  
Bangalore 3,  
March 3, 1948.

1. Winge, O., and Laustsen, O., *Compt. rend. d. Lab. Carlsberg*, 1939, **22**, (22), 357-74. 2. Winge, O., *Ibid.*, 1944, **24**, (8), 79-96. 3. Skovsted, A., *Ibid.*, 1943, **23**, (2), 409-56. 4. Subramaniam, M. K., *Proc. Nat. Inst. Sci. (India)*, 1947, **13**, (3), 129-39. 5. Subramaniam, M. K. and Ranganathan, B., *Nature*, 1946, **157**, 49. 6. Prema Bai, M., *Curr. Sci.*, 1947, **16**, 31C-17. 7. Muller, H. J., *Biol. Revs.*, 1939, **14**, 261-89. 8. Punkari, L., and Henrick, A. T., *J. Bact.*, 1933, **26**, 125-38. 9. Fabian, F. B., and McCullough, N. B., *Ibid.*, 1934, **27**, 583-24. 10. Braun, W., *Bact. Revs.*, 1947, **11**, (2), 75-114. 11. Subramaniam, M. K., *Proc. Nat. Inst. Sci. (India)*, 1946, **12**, 143-49. 12. —, *Curr. Sci.*, 1947, **16**, 157-58.

### CORRECT NAME OF *PLECTRANTHUS* *FRUTICOSUS* (BENTH) HOOK. f.

HOOKE, F.,<sup>1</sup> described a species of *Labiatae* under the above name based on *Coleus fruticosus* Benth.,<sup>2</sup> from the Palni Hills of South India. This plant was collected from the vicinity of Kodaikanal Lake by Bourne and is mentioned by Fischer<sup>3</sup> and Gamble.<sup>4</sup> Recently Fyson<sup>5</sup> also recorded the plant under this name, and in his revision of Indian *Labiatae*, Muker-

jee<sup>6</sup> has also kept up the name. Unfortunately, however, this name, being a later homonym is invalid according to rules.<sup>7</sup> It is pre-occupied by a distinct and different plant from South Africa—*Plectranthus fruticosus* L'Herit.<sup>8</sup> I have been able to trace the correct name for the South Indian plant which is *Plectranthus deccanicus* Briq.<sup>9</sup> and this name should be used to designate all the Indian herbaria sheets hitherto known as *Plectranthus fruticosus* (Benth.) Hook.f. non L'Herit. It appears that Briquet's new name, being published in a journal of comparatively less prominence has escaped the notice of botanists referred to above.

Bentham's reference<sup>2</sup> to *Wight Catalogue*, No. 2514, was misquoted by Hooker<sup>1</sup> as 2524. Neither of these numbers nor the name *Coleus fruticosus* could be found in *Wight's Catalogue*. Therefore, *Wight's* name should not be cited in connection with this plant.

Hooker's *Plectranthus urticifolius* (L.c. 6222) also requires a new name being pre-occupied by *Plectranthus urticifolius* (Lam.) Salisb.<sup>10</sup>; but as Mrs. M. Lewis is at present engaged in a revision of the genus (at Kew), I refrain from proposing a new name for this plant.

The Herbarium,  
Royal Botanic Gardens,  
Kew, Surrey,  
February 11, 1948.

D. CHATTERJEE.

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# ON THE HABITS OF THE EXOTIC MOSQUITO-FISH *GAMBUSIA AFFINIS* (BAIRD AND GIRARD) IN THE WATERS OF MADRAS

THE introduction and acclimatisation of *Gambusia affinis* in North India have been described by Mulligan and Majid.<sup>1</sup> In Madras, the species was introduced on two occasions. Firstly, in 1929 a consignment of 600 was imported from Ceylon by the Fisheries Department for stocking two nurseries attached to the Krusadai Biological Station. Secondly, a consignment of 100 was brought to Madras City from Bangalore in 1930 through the efforts of the Malaria Officer. Since then *Gambusia* has attained a local stand in the Province, and now occurs in many brackish water canals and creeks and in freshwaters from the coastal area up to an elevation of about 7,000 feet.

The following are the observations made from the provincial waters of Madras, showing variations from those of Kuntz,<sup>2</sup> Hildebrand<sup>3</sup> and Seale<sup>4</sup> on the bionomics of *Gambusia* from the waters of the Americas and the Philippines.

Maximum size : 5.2 cms. in males and 6.8 cms. in females.

Proportion of males and females : Equal.

Food : (1) *Insecta*, such as *Diptera* larvae, *Hemiptera* adults and larvae and *Coleoptera* adults and larvae : 45 per cent.; (2) *Crustacea*.—Copepods, Daphnids and Cypris : 15 per cent.; (3) Desmids and diatoms.—*Closterium*, *Cosmarium*, *Eunotia*, *Fragilaria*, *Melosira*, *Navicula*, *Pinnularia*, *Staurastrum*, *Synedra* and *Tabellaria* : 25 per cent.; and (4) Algal filaments of *Cladophora*, *Cedogonium*, *Oscillatoria*, and *Spyrogyra* : 15 per cent.

Maturity : Attained when 3 months old and about 3 cms. in size.

Breeding Season : Throughout the year with a maximal from October to November.

Eggs : 120, 1.8 mm. in diameter, in each ovary.

Parturition : 23 to 35 larvae liberated within 20 to 30 minutes. Post-natal recuperation of mother is by feeding on 5 to 8 young ones.

Description of Larva : 8 mm. in size. Transparent body with black eyes.

Post-larval development : Yolk-sac absorbed on sixth day. Pigmentation completed on 15th day. Adult characters assumed within eight weeks.

Communal Association : Its voracious habit has caused a striking diminution in the population of the indigenous form, *Aplocheilus blochii* (Jerdon).

Larvicidal propensity : Female consumes 260 mosquito larvae in a day, whereas the male takes in only about 60; hardy fish adapting to all types of lentic environments. Russel and Jacob<sup>5</sup> and Bhasker and Ramoo<sup>6</sup> have found the species useful for mosquito control even in shallow casurina pits and wells. Those longer than 30 mm. stand transport well.

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8, Ormes Road,  
Kilpauk, Madras,  
February 3, 1948.

P. I. CHACKO.

\* Communicated with the kind permission of the Director of Industries and Commerce, Madras.

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## ROLE OF PROTOZOA IN THE CONCENTRATION OF NITROGEN IN THE SLUDGE DURING AEROBIC PURIFICATION OF SEWAGE

THE importance of micro-organisms in the nitrogen cycle has long been recognised and considerable amount of attention has been devoted to the study of nitrogen conservation in soil and sewage.<sup>1</sup> Certain forms of protozoa, such as the species of *Hartmannella*, *Heteromita*, *Colponema*, *Colpoda*, *Colpidium*, and *Oxytricha*, have been found to stimulate bacterial fixation

of nitrogen.<sup>2-4</sup> It has also been suggested that a large part of the nitrogen found in activated sludge is traceable to its protozoan content,<sup>5</sup> though it has been contended that the increased nitrogen content of activated sludge due to the growth of protozoa is not necessarily very high.<sup>6</sup>

Further to our earlier observations on the special significance of *Vorticellids* in the aerobic purification of sewage and sludge formation,<sup>7,8</sup> we have carried out studies on the role of *Epistylis* sp. and *Vorticella* sp. in the concentration of nitrogen in the sludges.

Homogeneous faecal suspensions were treated as follows: (i) aerated as such (ii) inoculated with an active culture (16 ml.) of *Epistylis* sp. and then aerated; and (iii) inoculated with an inactive culture (16 ml. after heating to 60° C.) of *Epistylis* sp. and then aerated. The aerations were carried out for 120 hours and the sludges separating from representative samples analysed for their nitrogen contents. The results are given in Table I.

In another set of experiments, heat-sterilised suspensions of sewage, soil and compost were aerated with *Vorticella* sp. and 79 different strains of bacteria (characterised according to Bergey<sup>9</sup>) isolated from samples of water, sewage, soil, compost and faeces of animals. The influence of individual strains of bacteria from different sources on nitrogen concentration by

TABLE I  
Concentration of nitrogen in sludge as effected by protozoa

Medium	Total N (mg.) in faecal suspension (800 c.c.)	N (mg.) added to suspension as protozoa (alive or dead)	After 24 hours' aeration		After 120 hours' aeration	
			N (mg.) in sludge after deducting the N added as inoculum	% of faecal N concentrated in sludge	N (mg.) in sludge after deducting the N added as inoculum	% of faecal N concentrated in sludge
Faecal suspension alone	24.64	..	1.2	4.9	6.3	25.6
Faecal suspension + <i>Epistylis</i> sp. (active)	24.64	10.6	15.9	64.5	12.3	49.9
Faecal suspension + <i>Epistylis</i> sp. (dead)	24.64	10.6	4.2	17.0	6.0	24.4

the end of 24 hours is more pronounced than when faecal suspension alone is aerated. The effect may be due to either some mechanical

TABLE II  
Influence of different bacteria on nitrogen concentration by protozoa in sludges

Sources of bacteria	No. of bacterial strains isolated	Medium for sludge formation	No. of strains without effect on nitrogen concentration by <i>Vorticella</i> sp.	No. of strains affecting nitrogen concentration by <i>Vorticella</i> sp.			
				No. of strains	% increase of N in sludge	No. of strains	% decrease of N in sludge
Water samples from bore-wells, tanks and river	11	Sterilised sewage	Nil	4	0.53-2.01	7	0.96-15.77
Garden soil	6	Sterilised soil suspension	Nil	Nil	..	6	0.29-17.00
Compost heaps	13	Sterilised compost extract	3	3	0.47-2.84	7	0.49-12.93
Raw sewage	2	Sterilised sewage	Nil	1	0.49	1	2.07
Septic tank sludge	2	"	2	Nil	..	Nil	..
Activated sludge	3	"	Nil	Nil	..	3	0.64-0.75
Cow dung	7	"	Nil	2	0.04-0.60	5	0.26-1.76
Horse dung	8	"	Nil	4	0.55-1.70	4	2.83-11.04
Faeces of other animals (rat, rabbit, dog and monkey)	27	"	3	13	0.26-3.61	11	0.17-9.93

1 c.c. of active bacterial culture was used as inoculum in each case; the protozoan inoculum contained about 20,000 active cells of *Vorticella* sp.

*Vorticella* sp. in the sludges as obtained after aeration of the media for 96 hours was studied (Table II).

It may be seen from Table I that there is rapid concentration of nitrogen in the sludge when the *Epistylis* sp. is introduced. This nitrogen is, however, partly lost when the aeration is continued for 120 hours. In presence of dead protozoa the concentration of nitrogen at

action of the dead cells or some associated substance, active even after destruction of protozoa.

As will be seen from Table II, very few of the isolated bacteria augment the action of protozoa. On the other hand, some of the bacteria seem to be fairly efficient in reducing the nitrogen content of the sludge.

The trend of evidence would suggest that



while the protozoa are efficient in concentrating the nitrogen in the sludge in the early stages, many of the associated bacteria produce a reverse effect when the aeration is prolonged. A small part of the nitrogen gets nitrified and passes into the effluent. The major part would still remain to be accounted for. The extent to which the latter passes into the effluent or is lost from the medium requires further study.

In actual practice, the total period of aeration in the Activated Sludge tank would be only a few hours. Raw sewage keeps on entering at one end, while the effluent continuously passes out at the other end. Under these conditions, there would be no scope for any secondary bacterial action leading to any loss of nitrogen from the sludge. If the aeration is prolonged, however, or during periods when little or no fresh sewage enters the tank, the secondary action may take place to some extent.

It is not clear whether any fixation of atmospheric nitrogen takes place through the direct or the indirect agency of either *Vorticella* sp. or *Epistylis* sp. This aspect would require careful study in view of the earlier observations<sup>10-11</sup> in regard to the fixation of atmospheric nitrogen in Activated Sludge. This important as-

pect is now under study and will be the subject of a later communication.

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Indian Institute of Science, T. K. WADHWANI.  
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## INDIAN RESEARCH COUNCIL

THE Governing Body of the Council of Industrial and Scientific Research met at Delhi in the first week of February 1948 to consider a number of schemes and projects of research and industry.

A Committee was set up to work out the details of a scheme for the manufacture of synthetic petrol from low-grade coal. The Council decided that intensified geological and geophysical exploration of possible areas of occurrence of petroleum in India should be carried out by the Government. It was also recommended to the Government that the possibility of buying crude petroleum from the Iranian and Burma oil-fields and refining it at two or three refineries at Indian ports should be explored.

On the recommendation of the Fuel Research Committee the establishment of three field survey stations for research in coal in the C.P., Raniganj and Bokhro-Raigarh coal-fields at a cost of Rs. 9 lakhs was approved. It was also recommended to the Government that a statutory cess of half anna per ton of coal despatched in India should be levied for aiding fuel research in the country.

It was also decided to have detailed plans for carrying underground gassification of coal which has brought about revolutionary changes in fuel technology in the world, particularly in Russia and the U.S.A.

To promote the development of dyestuffs both the educational and on the industrial research sides, the Council agreed to provide additional funds to the Bombay University for the creation of a professorship in Dyestuff Technology and for the institution of six research fellowships. The Council has been granting for some time to the Bombay University an annual recurring grant of Rs. 25,000 for the Department of Dyestuff Technology which will now be increased to Rs. 54,000. Fifty per cent. of the seats in the department will be reserved for students belonging to Provinces other than Bombay.

Two important schemes in the field of atomic research, viz., theoretical studies in the properties of Meson Field and biological aspects of atomic research, were sanctioned at a cost of Rs. 50,000. The latter scheme will be investigated at the Tata Memorial Hospital in Bombay.

Revised plans of the Central Institute of Drug Research, the establishment of which was approved last year, were accepted by the Council at its meeting. The Institute will be established at a capital cost of Rs. 20 lakhs and will cover a very wide scope of activity.

The Indian Chemical Manufacturers' Association have also agreed to finance the Institute to a considerable extent. A Special Committee with Dr. Jivraj Mehta as Chairman has been set up to select a suitable place for the location of Institute.



## REVIEWS

**Alternating Current Electrical Engineering.** By Philip Kemp. (Macmillan & Co., Ltd. London), 1947. Seventh Edition. Pp. ix + 659, with 450 figures. Price 25s. net.

The applications of electricity to human needs and comfort are so great and growing that it has become indispensable to the daily life of the community and of the individual. It is difficult to imagine to-day a world without electricity. Inevitably, electrical engineering, specially alternating current electrical engineering, continues to develop unceasingly in every direction. No text-book even of the size of the one under review can, therefore, deal with more than the essential principles of carefully selected aspects of the subject. This is what Prof. Kemp seeks to do in this book on alternating current electrical engineering, and he is an author and teacher of long standing well known in his field. Of the quality of the book and its popularity, it is enough to note that since it was first published in 1918, it has run through seven editions and been reprinted twice.

This is not a specialist's book nor is it addressed to the designer of alternating current machinery and equipment. It is meant for the student of electrical engineering preparing for his bachelor's degree or its equivalent, and for the "engineers whose student-days are over" and who may wish to "use it to refresh their memories when called upon to solve problems which are out of their normal course of work".

An adequate grasp of the general theory of alternating currents is an indispensable requisite to a study of this branch of electrical engineering; it is, therefore, satisfactory that a quarter of the book is devoted to a discussion of it in the first thirteen chapters; the ground covered includes the vectorial and the symbolic methods of representing alternating quantities, inductance and capacity as circuit elements, resonance, power and power factor, polyphase currents and rotating fields. In addition, there are chapters on Transients and Oscillatory Circuits at the end of the book; but a more suitable place for these would be after Chapter VIII.

These provide the basis for the succeeding chapters, 14 to 32, on the different types of alternating current machinery, starting with the transformer and ending with three-phase commutator motors and power factor control. The treatment is more detailed and comprehensive in the cases of the transformer, the alternator and the induction motor. There is a separate chapter on the principles of design in each of these three cases. The author takes care, and very rightly, to point out in the Preface that these chapters "do not constitute a design manual" and that design "can only be learned by experience in actual practice".

In revising the book for the present edition, the author has endeavoured to bring the book up-to-date not only in the treatment of the

different aspects of the subject, but in including within its pages a number of important developments or recent years. The selsyn principle, for example, which is being applied so increasingly during and since the war is explained under Induction Motors (p. 369). The chapter on Rectifiers includes a discussion of the phase and bias control of ignition and a brief mention of the copper oxide rectifier. Chapter 32 on the Three-Phase Commutator Motor mostly deals with the Schrage Motor along with a brief explanation of the No-Lag Motor. Lead oxide and Thyrite Arrestors are discussed under Protection of A.C. Systems.

The role of electronics and electron tubes in every branch of electrical engineering is so great and increasing so rapidly that no electrical engineer can now-a-days do without a study of it. It is a part of his professional equipment. It is, therefore, surprising that it should have been deliberately omitted from the scope of the book; the omission is all the more notable as the author has included subjects like the mercury arc rectifier, the cathode-ray oscillograph, oscillatory and coupled circuits and even the obsolete spark method of producing oscillatory currents. By including a brief exposition of electronics, the book would have gained in value without any serious increase in its size and cost.

The printing and the general get up of the book leave little to be wished for. But a special word of praise is due to the 450 figures that illustrate the text. At the end of each chapter there are a selected number of examples, the solutions for which are given towards the end of the book. The explanation is everywhere clear and concise and the mathematical treatment adequate and within reach of the student for whom the book is intended. No errors were noticed in the text. No references are given to original papers; this in many ways is an advantage to the beginner.

One or two matters, however, call for comment. On page 11, what the author means by Ohm's Law is not very clear; nor is the explanation on pages 58 and 59 on the current in a condenser. Why not follow Maxwell's explanation that a changing electric field constitutes an electric current the value of which is proportional to the rate of change of the field? This, every time is the simplest and the best explanation. On page 16, it is stated that the induced e.m.f. in an inductance opposes the applied e.m.f. producing the current. This surely is not right. The induced e.m.f. adds to or opposes the applied e.m.f. according as the current in the inductance is either decreasing or increasing. Another matter of some importance is the definition of the phase of an alternating quantity and the difference of phase between two such quantities. The book is certain to serve as a valuable guide to students of electrical engineering.

R. E.

**The Growth of Physical Science.** By Sir James Jeans. (Cambridge University Press), 1947. Pp. 364. Price 12sh. 6d.

The book under review is the last one written by Sir James Jeans before his death in September 1946. The late Sir James Jeans was known throughout the world for his lucid exposition of science in books intended for the general public. The present volume forms yet another example giving testimony to the author's wide range of interest and knowledge and also to his splendid gift of exposition.

The history of science is truly the story of the great originators. In keeping with this, the author traces the life-histories of the prominent men of science and their contributions to physics including mathematics and astronomy. The arrangement is such that we get a coherent account of the growth of modern physical science and the steps by which it has attained its present state and importance. The author has also given an account of the progress of mathematics which, as is well known, is intimately connected with the progress of physical science.

The book is divided into eight chapters, each one dealing with the growth of science during a specific period. Chapter I contains an account of the remote beginnings during the three millennia of Babylon and Egypt starting from the earliest evidence of the systematic interest in science coming from the civilisation which existed in the river basins of the Euphrates and the Nile in the new-stone age. The second chapter refers to the period covering the first three centuries (600-320 B.C.) of scientific progress in Greece which was almost entirely mathematical, forming a sort of intellectual golden age. The next chapter deals with science in Alexandria which became the intellectual centre of the world for many generations (322 B.C.-A.D. 642). Chapter IV deals with the causes for the stagnation of scientific progress during the next eight hundred years. Jeans has aptly described this period as the dark age as far as science was concerned. The spread of Christianity and Islam during this period was largely responsible for strangling the growth of science and bringing about ultimately the decline of Alexandria, the great city of learning. During this era, education and scientific knowledge were almost the exclusive prerogative of the church. The renaissance of the scientific spirit which followed the invention of the printing press in Europe is described in Chapter V. This period (1452-1600) started with the birth of Leonardo da Vinci who was the first to approach the study of nature in a truly modern spirit. With Leonardo science began to adopt modern aims and methods. The noteworthy advances made in astronomy, mechanics and mathematics respectively by Copernicus, Stevinus, Galileo and Fontana in the sixteenth century are detailed in the same chapter. The progress of science in the seventeenth century (described as the "Century of Genius") is contained in Chapter VI. A detailed account is given of the many valuable contributions made to astronomy notably by Kepler, Galileo and Newton, to optics by New-

ton, Hooke, Huygens and Snell, to the knowledge of the structure of matter by Boyle, and to mathematics by Descartes, Fermat, Cavalieri and Leibnitz. Chapter VII refers to the period covering two centuries after Newton (1701-1897). This period, if not so strikingly brilliant as its great predecessor, was at least one of solid progress. It provided an abundance of first class investigators like Lagrange, Hamilton, Laplace, Bradley, Herschel, Young, Fresnel, Fizeau, Lavoisier, Dalton, Kelvin, Faraday and Maxwell, to mention only a few. Finally the era of modern physics which commenced with the famous Michelson-Morley experiment (1887) is dealt with in the last chapter. The tremendous progress made during the last sixty years has been beautifully summarised in about seventy pages.

Although detailed reference has been made in the book to the contributions made to the progress of physics and astronomy by numerous investigators in various countries of the world, one looks in vain for adequate reference either to ancient Hindu astronomy or to the important contributions of Indian scientists especially in the field of physics and astronomy in recent years. Except for this omission, the story of the growth of physical science starting with the Babylonian system of counting and ending with the recent ramifications into the mystery of the sub-atomic structure, is told in a fascinating manner in this volume. The book has been written in a simple and elegant style so as to interest even the layman. The book will be extremely informative not only to students of physics but also to the general reader who wishes to enrich himself with the knowledge of the growth, achievements and potentialities of physical science.

R. S. K.

**High Polymers, Vol. VII.—Phenoplasts.** By T. S. Carswell. (Interscience Publishers Inc., New York), 1947. Pp. 267. Price \$5.50.

This handsome book on Phenoplasts, their structure, properties and technology, is a welcome addition to the library of the plastic chemist. The book deals with the recent developments in the study of phenoplasts. Subdivided into several sections with brief introductions for most of them the book gives a good account of the general reactions of phenols and aldehydes, the physical structure of the resins, the various types of fillers used in molding compositions, the mechanical, electrical and thermal properties of the phenoplasts. In the concluding sections are briefly given the technical manufacture, the molding technique and the miscellaneous technical applications of the phenoplasts, intended for the research chemist, as the author rightly points out in the preface to the book. Emphasis has been laid on the recent developments of the study of phenoplasts, and the book gives considerable data on present trends in the development of the phenoplastics.

The book is well indexed, nicely got up and deserves a place in any scientific library.

M. S. MUTHANNA.

**Annual Report of the Public Health Commissioner with the Government of India for 1945.** (Manager of Publications, New Delhi.) Pp. 84 + vi, with 2 maps and 5 charts. As. 14.

The detailed Annual Report of the health activities in British India which was temporarily suspended during the years 1941 to 1944 has been resumed from the year 1945. The year under review saw the termination of the global war first in the European and then in the Pacific theatre. The world was left with war-weary, under-nourished population on a scale not previously encountered. The pandemic of influenza of the type which swept countries after World War I was feared, and special watch was maintained at ports to check immediately any importation of influenza into the country. Another notable feature is the vigilance with which the air-port authorities at Karachi worked for effectively stemming the introduction of yellow fever into India as the aerial traffic to India, especially through North Africa was greatly increased owing to war conditions.

India continues to be the largest reservoir of the infections of smallpox, cholera and plague, the reason being the low level of the environmental sanitation and the absence of a controlled and protected water supply for the vast rural population and the chronic malnutrition aggravated by war conditions. Lack of medical and sanitary personnel with the civilian administration of the provinces and in some cases inadequate supply of drugs and disinfectants hampered control of infectious diseases. The control of epidemic diseases at fairs and festivals has improved considerably, and this measure has materially reduced the danger of spread of epidemics by pilgrims. The *Ardh Kumbh Mela* in the United Provinces had always been followed by a heavy incidence of cholera in the Punjab during April. It is gratifying that this year no case of cholera was reported. The death rate for British India decreased from 24.1 per million in 1944 to 21.5 in 1945. With the exception of Central Provinces and Orissa the death rates in 1945 were on the same level as in pre-war years. On the other hand, birth rate increased from 25.4 per million in 1944 to 27.3 per million although the pre-war birth rate of 34.5 per million has not been touched. There was no abnormal incidence of malaria anywhere except in Orissa, Central Provinces and in some parts of Madras. The usual activities for the distribution of quinine or its substitutes and the adoption of anti-larval and anti-adult mosquito measures were carried out throughout British India. Useful work continued to be done by the Department as regards anti-tuberculosis work. Inadequacy of institutional arrangements to deal with actual cases and their contacts remains the same as before.

The unique event in the history of Health Planning in India was the completion of the report of the Health Survey and Development Committee under the chairmanship of Sir Joseph Bore. This Committee, in consultation with the distinguished workers in the field of health from the U.S.A.,

U.S.S.R., and Australia, has given a comprehensive survey of existing Indian conditions together with recommendations and plans which, if successfully put into operation, goes a long way in improving the health of the rural and urban population of India.

Medical Research in India has shown considerable progress extending over a wide field—problems relating to the control of malaria, cholera, plague and leprosy. Nutrition Research has taken a prominent place, and a number of useful inquiries regarding the role of vitamins especially vitamins B, C and D, and proteins in health and disease were in progress. Experimental trials on Monkey malaria were carried out with Palludrine and the drug promises to be superior to Mapacrine. Welfare work by voluntary organisations such as the Indian Red Cross Society, Tuberculosis Association of India, British Empire Relief Association (Indian Council) and International Health Division of the Rockefeller Foundation in India and others have contributed a great deal towards the improvement of public health in the various provinces and Indian States.

There are two maps and several interesting and explanatory charts which enhance the value of the Report.

A. S. RAMASWAMY.

**Records and Research in Engineering and Industrial Science.** By J. Edwin Holmstrom. (Chapman & Hall, Ltd.), 1947. Pp. xii + 366. Price 21sh. net.

The progress of scientific and technical research in any subject cannot flourish in isolation; it must be collated at all times for the use and guidance of all scientific workers. To compile such information, to serve as a ready guide to all those interested, is a difficult task, and Dr. Holmstrom's book shows how to overcome these difficulties. The book can be broadly divided into three parts. In the first part the author emphasizes the importance of collation of fundamental research in relation to engineering industry, and of statistical examinations providing the key to questions of technical design so vital to the progress of the industry. That the pace of advancement in technical fields quickens through a properly divided team-work is clearly set out by the author who quotes appropriate examples. In the other part of the book he gives an outline of the British Collations and International Organisations for the promotion of Scientific Research and makes a passing reference to Indian National and other organisations. In the third part he deals with the recording and circulation of technical information, indexing, photographic reproduction, microphotography, translation of foreign languages and other allied subjects; the author also presents his own system of classifications. On the surface of it, organisation and administration of a technical library appears an easy affair. To provide a research worker exactly and expeditiously material he wants at the moment, is not very simple. This book shows in a very clear style librarianship in recording all the valuable information about research on technological subjects. It is hoped that every librarian will be greatly benefited by a study of this very useful book.

M. S. T.

**Surveying of Existing Information and Data on Radio Noise over the Frequency Range 1-30 Mc/s.** (Published by the Department of Scientific and Industrial Research.) RADIO Research Special Report, No. 15.

This report is probably the first of its kind to supply information on most of the available published literature dealing with all types of noise, whether of man-made, atmospheric or extraterrestrial origin encountered in radio reception, in the frequency range 1 to 30 mc/s. The present report has been prepared and presented in as coherent a form as possible, before embarking upon a long-term research in order to supplement our existing knowledge of the nature, origin, prevalence, intensity of different types of noise that affect radio reception in the frequency range mentioned.

Noises that can spoil satisfactory reception have been classified as receiver, thermal, cosmic, atmospheric and man-made. It has been shown: how a thorough theoretical and practical consideration lead to a proper assessment of noise levels at various locations.

The report, consisting mainly of nine sections, deals with receiver noise both internal and external, and thermal noise in sections 2 and 3 respectively.

The fourth section discusses noise due to cosmic radiation. This has the characteristics of fluctuation noise and affects the reception within 15 to 30 mc/s. It is recommended in this connection that further experimental information should be collected from all parts of the world with more refined equipment in order to assist in the eventual development of a satisfactory explanation which will prove to be a valuable contribution to the domain of both radio communication and astrophysics. The fifth section deals with atmospheric noise which produces clicks, crackles or crashes in radio reception. Information regarding the diurnal, seasonal and annual variation of noise level at various locations are recorded. Consideration is given to the theories of charge separation and initiation of discharge and also the manner in which the intensity is affected by effects of earth curvature, sky-wave reflections, etc.

Section six deals with various types of man-made noise. It is suggested that, with suitable precautions at the source and the receiver end, the effect of this interference can be made inappreciable.

Section seven discusses amplitude and frequency characteristics of both fluctuation and impulsive noise. Section eight describes various methods of noise measurement and suggest that the existing methods need much improvement before any satisfactory conclusions can be arrived at from such measurements.

The report ends with certain valuable recommendations in Section nine for increasing our existing knowledge. Many new problems have been suggested so that the report is valuable not only as scientific information but also as guide to the workers in this field.

S. K. C.

**Nutrition in Relation to Cancer.** *Annals of the New York Academy of Sciences*, Vol. XLIX, Article 1, pages 1-140. (Published by the Academy), September 1947.

It is generally believed that in spite of a large number of persons working on cancer, no really worth-while discoveries have been made relating to either the causation or the treatment of malignant disease. This belief is only partly true, because cancer research is dependent on our knowledge of fundamental life processes in tissues and their cells, and our ignorance of these processes is still abysmal. However there is an effort from several directions for arriving at a clearer understanding of the biological phenomenon of growth and also of abnormal growth of cancer. A good deal of very valuable knowledge has accumulated as a result of the patient study by "meticulous plodders", medical men, biochemists, physicists and biologists and it appears that gradually this knowledge is taking shape like pieces of a jigsaw puzzle.

One of the recent observations relates to the important role which nutrition plays in development of tumours in mice and men. The New York Academy of Sciences is, therefore, to be congratulated in bringing together men working on different aspects of the problem of *Nutrition in Relation to Cancer* and publishing a resumé of their observations in the form of a booklet. It is a compilation of papers read by recognised workers in the field of cancer research in U.S.A. at a conference organised by the New York Academy of Sciences and Panel on Nutrition, Committee on Growth, National Research Council in December, 1946. The papers deal with the researches carried out on the effects of varying caloric intake upon tumours, the mechanism of effects of increased intake of fats, carbohydrates and other dietary factors on carcinogenesis, the role of vitamin B complex, the milk-borne mammary-tumour producing agent in mice, etc. The workers in medical institutions will be particularly interested in a new orientation to the problem from a study of plants (Robbins), chemically induced mutations (Tatum) and nutrition of monocellular organisms (Kidder), which are fields of investigation usually outside their purview.

The paper on caloric intake is important, as data are presented which show that caloric restricted diet inhibits the production of several types of mouse tumours. Miller reviews a phase of studies by the Wisconsin group on the carcinogenic azo dyes and the remarkable effect that diet exerts in the production of liver tumours. His findings on the incidence of these tumours agree with those observed by workers in this country in the laboratories of the Tata Memorial Hospital. White and his associates have observed a reduction in the incidence of leukemia from 92.1 to 55 per cent, in a group of animals kept on cystine-restricted diet. It might have been better if the sex of the animals in the two groups had been mentioned. Tatum has dealt very ably with the mutation theory of cancer, which is attracting much attention at the present moment and has stated the present-day position as "many of the known facts regarding the changes taking place during carcinogenesis seem to support this theory, and



perhaps none are in actual disagreement". One of the important contributions is by the Alabama group (Copeland *et al.*) who have demonstrated the occurrence of neoplasms in 40 out of 69 rats with diets deficient in choline and related nutrients. The choline-deficient diet gave rise to neoplasms in lung, liver, pancreas, bladder in these animals. The number of animals is probably too small for the number of diets used and it is necessary to extend these remarkable findings. The work by Kensler on the demethylation of the dye, *N*-dimethyl aminoazobenzene, and his experiments on the inhibition of succinoxidase activity of rat liver slices is already well known, and has opened up a new field for future work.

The booklet is recommended for careful study by all persons interested in problems dealing with cancer or nutrition.

V. S. WARAVDEKAR.

**The Terpenes.** Vol. I.—*The Simpler Acyclic and Monocyclic Terpenes and Their Derivatives.* By J. L. Simonsen. Second Edition, revised and reset by J. L. Simonsen and L. N. Owen. (Cambridge University Press), 1947. Pp. 479. 30sh. net.

The first edition of this valuable contribution to the chemistry of terpenes was published in 1931. The plan and scope of this edition remains unaltered, but much new material has been added: Angustione, dehydroangustione, leptospermane, cryptone, piperitone, isopiperitenone and greater information concerning a large number of other substances are included. The elucidation of the extremely difficult problem of preparing purified specimens of the isomeric menthones, menthols, etc., has engaged the attention of a number of workers for a large number of years, and in recent years Read and his collaborators have paid much attention to this question. Menthol contains three asymmetric carbon atoms, and the problem of the configuration of Menthol, neo-Menthol, iso-Menthol and neo-iso-Menthol and their relationship to Menthone and iso-Menthone, discussed in detail, is one of the outstanding developments since the publication of the first edition. The relationship of the optically active menthols to 1-Piperitone is also now clear.

The formula originally assigned to irone by Tiemann and Kruger has undergone revision at the hands of Ruzicka and his collaborators. A study of the ozonolysis followed by oxidation, with chromic acid led to the isolation of tri-substituted pimelic, adipic and glutaric acids, which leave no doubt that irone has a seven-carbon-atom ring structure. The carbon skeletons of the acyclic and alicyclic substances may be considered to be built up by the fusion of isoprene nuclei, and this has proved a greatly reliable working hypothesis for the elucidation of structure. It should, however, be regarded only as a working hypothesis since several exceptions are known. No very satisfactory conclusion has yet been arrived at concerning the origin and function of terpenes and their oxygenated derivatives produced by plants.

In this edition, as in the previous one, the development of the views on the constitution of the various terpenes has been traced in a very clear manner; and indications of further research necessary to settle outstanding questions

have been pleasantly treated so that the student of terpene chemistry will find no difficulty in following the trend of thought.

The book is an outstanding contribution in the field of organic chemistry in general, and terpene chemistry in particular.

K. N. M.

**Modern Gas Turbines.** By Arthur W. Judge. (Messrs. Chapman & Hall, Ltd., London), 1947. Pp. xii + 311. Price 28sh.

The gas turbine has already proved itself to be a serious rival to the reciprocating engine in some important fields of use. Granted the requisite knowledge and facilities, it can be cheaper to make than corresponding reciprocating engines; moreover, moderate metallurgical advances in certain directions will greatly increase the extent to which the gas turbine can outrival reciprocating engines. Thus, it may be good policy for India not to contemplate eventual manufacture of certain larger and more difficult types of reciprocating internal combustion engines but, instead, to go direct to gas turbines. It is thus patent that the subject of the book under review has a special interest for India.

To those who require to assess the possibilities and limitations of gas turbines for various fields of application, Mr. Judge's clear exposition will be of considerable help at the present stage. The author gives a brief history of the development of gas turbines and follows this with some general considerations. He then outlines the fundamentals of gas turbine thermodynamics and discusses gas turbine efficiencies and how to improve them. There follows a chapter on closed-cycle gas turbines and another on exhaust-gas turbines for supercharged engines. The next chapter deals with gas turbines for aircraft. This relates mainly to jet-engines as more experience has been gained with these engines than with those which deliver power through shafting. The concluding two chapters concern typical applications and performances of gas turbines, and materials for gas turbines. There are two short appendices which comprise notes on turbine-blade design and a description of some blade-fixing methods.

A considerable bibliography is given for the guidance of those who need to study particular aspects of the subject more fully. Important further contributions continue to appear in technical literature but the references given extend into 1946.

The book is not a design manual. It is largely descriptive, but fundamental principles and facts are stated thus forming an excellent introduction to the subject.

Little is given concerning dynamical aspects of gas-turbine design, such as balance, whirling, vibration of turbine discs and blades centrifugal and temperature stresses, high-speed bearings, and so forth. To a large extent these are covered by manuals on steam turbine design, but the gas turbine has its own special dynamical and stress problems. Again, heat interchangers for gas turbines are referred to only diagrammatically. However, it is to be realised that there is limitation to information released.

The book is clearly printed and is well-illustrated by numerous graphs, drawings and photographs.

B. C. CARTER.

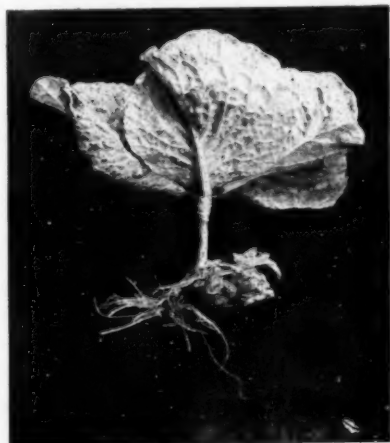


## SCIENCE NOTES AND NEWS

### Cabbage Crinkled-Leaf Var. belonging to the Genus Brassica

Dr. T. S. Sabnis from Cawnpore writes:—

One of the cabbage plants of the crinkled-leaf variety did seem to develop a proper head. When it was dug out, it showed a head-like



structure developed near one of the lateral roots (fig.). It may be a phenomenon of proliferation of buds from the root.

### National Institute of Sciences of India: Elections

At the annual general meeting of the National Institute of Sciences of India, held at Patna on January 1, the following new fellows were elected: Dr. B. S. Bhimachar, Fisheries Officer with the Government of Mysore, Bangalore; Pratap Chandra Bose, Chief Engineer, Corporation of Calcutta; Dr. Satya Charan Chatterjee, Head of the Department of Geography, Patna College, Bankipur, Patna; Jehangir Fardunji Dastur, Head of the Division of Mycology, Indian Agricultural Research Institute, New Delhi; Dr. Arun Kumar Dutta, Reader in Physics, Dacca University; Dr. Rukmini Kishore Dutta Roy, Geological Survey of India, Calcutta; Dr. Robert E. Heilig, Chief Physician, Jaipur; Dr. Kolar Ramakrishna Krishnaswami, Director of Industries, Bihar, Patna; R. A. MacGregor, formerly Chief Metallurgist to the Government of India, Calcutta; Ganesh Chandra Mitter, Chief Assayer, His Majesty's Mint, Bombay, and Honorary Professor of Industrial Chemistry, Royal Institute of Science, Bombay; Dr. Mahadeo Atmaram Moghe, Professor of Zoology, College of Science, Nagpur, and Head of the Department of Zoology and Dean of the Faculty of Science, Nagpur University; Dr. S. P. Raju, Director of the Engineering Re-

search Department, H.E.H. Nizam's Government, Hyderabad, Deccan; Dr. Srinivasa Ramamujam, Central Potato Research Institute, New Delhi; Dr. Subbarao Ramachandra Rao, Professor of Physics, Central College, Bangalore; Dr. Jyotis Chandra Ray, Director, Indian Institute for Medical Research, Calcutta.

### Royal Asiatic Society of Bengal

The following are the recipients of Medals of the Royal Asiatic Society of Bengal:—

*Barclay Memorial Medal.*—Rai Bahadur K. C. Mehta.

*Joy Gobind Law Memorial Medal.*—Dr. Lieven Ferdinand de Beaufort of Amsterdam.

*Paul Johannes Bruhl Memorial Medal.*—Prof. S. R. Bose.

*Dr. Bimala Churn Law Gold Medal.*—Dr. B. M. Barua.

*Sir Jadunath Sarkar Gold Medal.*—Sir P. S. S. Pissurlencar, Nova Goa.

### Madras University Prizes

Candidates are invited to submit theses for the award of the following prizes awarded by the University of Madras: Sir William Wedderburn Prize (1948); The Maharaja of Travancore Curzon Prizes (1948-49); The Gokhale Prize (1948-49); and The Shankara Parvathi Prize (1948-49).

The subjects and last dates of submission of theses, the values and conditions of award and other particulars may be found in Vol. I, Pt. I, Appendix F of the University Calendar, Madras.

### International Geological Congress

The eighteenth session of the International Geological Congress will be held in London during the period August 25 to September 1, 1948. Prof. H.H. Read is the President-designate of the Congress.

Full details may be obtained from the General Secretaries of the Congress, Geological Survey and Museum, Exhibition Road, London, S.W. 7.

### International Congress of Anthropological and Ethnological Sciences

The third session of the Congress will be held at Brussels Teruveren during August 15-23, 1948. The President will be Prof. Ed. De Jonghe and Secretary Prof. Frans M. Alberechts. Correspondence should be addressed to the Secretary, Muscee du Congo Belge, Teruveren, Brussels.

### Captain Inderjit Singh

Captain Inderjit Singh, F.A.S.C., Professor of Physiology, Dow Medical College, Karachi, has been appointed Professor of Physiology, Medical College, Agra.

### Army Medical Training

India's armed forces will soon have their biggest medical training centre established in Poona. The main nucleus of the centre will be provided by the Army Medical College, already functioning at Ganeshkhind in Poona, and it will bring about a co-ordination in the activities of this College and other similar military institutions, such as the Central Pathological Laboratory, the Blood Transfusion Centre, the School of Radiology and the Typhus Research Station.

### Scientific Education through Films

Mr. K. C. Reddy, Chief Minister, Mysore, inaugurated the Scientific Film Society on the 29th February in Bangalore.

Prof. M. S. Thacker of the Indian Institute of Science, the Vice-President of the Society, welcoming the Chief Minister, stressed the need for such a society to educate the people in scientific progress and technical developments through the medium of films.

The Scientific Film Society, of which Sir J. C. Ghosh is President, is the first of its kind in India. Its membership is open to all. The Society proposes to produce and exhibit films on scientific subjects in a way which can be easily understood by the common man.

### Donation for Electro-Chemical Research

Dr. R. M. Alagappa Chettiar has made a munificent donation of Rs. 15 lakhs towards the establishment of an Electro-Chemical Research Institute in South India under the auspices of the Indian Research Council.

The Governing Body of the Council has sanctioned a sum of Rs. 6.5 lakhs for the renewal of 100 research schemes which are in operation in various universities and research institutions all over India under the auspices of the Council.

The Governing Body of the Council of Scientific and Industrial Research sanctioned the following new schemes of research entailing a cost of Rs. 87,000 and recommended by the Board of Scientific and Industrial Research, which also held its meeting on February 5, in New Delhi, under the presidency of Pandit Jawaharlal Nehru: (1) Investigations on uranium, thorium and radium content of Madras granites and gneisses, and their intrusive suits, including the Cuddapah traps, by Dr. R. S. Krishnan. (2) Recovery of primary metals from non-ferrous scrap, by Mr. G. C. Mitter. (3) Investigation of a general effect of light on the electrical conductivity of systems activated by various types of discharge, by Dr. S. S. Joshi. (4) Study of the properties of crystalline quartz, particularly the piezo-electric, optical and twinning properties in relation to its crystal structure, by Dr. Bishambar Dayal Saxena. (5) Scheme of research on synthetic fibres from proteins, by Sir S. S. Bhatnagar. (6) Preparation of vinyl plastics from alcohol and chlorine, by Dr. S. K. K. Jatkari. (7) Pilot plant investigations on the production of acetic acid from ethyl alcohol, by Sir J. C. Ghosh. (8) Effect of radiation on moulds, bacteria, etc., in relation to their metabolism, by Dr. B. C. Guha. (9) Manufacture of vitamin C from sorbose, by Dr. M. Damodaran. (10) Study of surface-

active higher alkyl ammonium actions as anti-bacterials, by Dr. M. Damodaran. (11) Study of Microbiological methods for the estimation of complex organic substances of industrial and nutritional importance, by Dr. M. Damodaran. (12) Preparation of phosphanilic and related substances, by Prof. S. V. Bhide.

### Leather Technology

It has been decided to locate the proposed Institute of Leather Technology at Guindy under the name of the Indian Leather Research Association.

This decision followed discussions which Sir Shanti Swarup Bhatnagar, Director of the Council of Scientific and Industrial Research, Government of India, had with Mr. H. Seetharama Reddi, Minister for Industries, Madras.

### Power Alcohol in India

The Commerce Minister to the Government of India, Mr. C. H. Bhabha, introduced in the Dominion Parliament a Bill to provide for the development of the power alcohol industry on the 1st of March.

The statement of objects and reasons of the Bill says: "The development of the power alcohol industry is of national importance both from the point of view of using the molasses which would otherwise be wasted, and of creating in the country the nucleus of an industry which would be of importance in times of emergency. The utilisation of power alcohol would also reduce the price of sugar and reduce our dependence on petrol. It would, however, not be possible for most of the provinces producing molasses to absorb their total production of power alcohol within their own limits. It is, therefore, necessary to adopt measures to utilise their surpluses in other provinces in which production would not be sufficient to meet their requirements.

The panel for the development of sugar, power alcohol and food yeast industries which was set up by the Government of India recommended that admixture of power alcohol with petrol should be made compulsory for the whole country and enforced in such areas as are notified from time to time. The Industries Conference, held in December 1947, in which representatives of Provincial and State Governments participated, also unanimously passed a resolution in support of the proposed legislation.

### Metal Films by Evaporation

A continuous process of applying, by evaporation, films of metal to the surfaces of sheet materials has been developed by National Research Corporation, Cambridge, Massachusetts.

While such metals as aluminium have long been applied to the surface of glass or other material by batch methods, their quick, continuous application to continuous rolls at high speeds has not been practical until now. The National Research process applies extremely thin films of aluminium, silver, gold, zinc, copper and other metals to the surfaces of papers, textiles and various plastic sheets at linear speeds of hundreds of feet per minute.

Because of the extreme thinness of the film, the flexibility of the base material is not affect-

ed; and the moisture vapour transmission is reduced. Adhesion varies with the material. Finish is limited only by that of the base material, and on polished surfaces the brilliance exceeds that of foil. The method is claimed to be inherently more practical and economical than the rolling of foil, and its cost is materially lower.

At present the process recommends itself for use in decorative materials of great variety—wrapping papers, ribbons and novelty fabrics and particularly those packing materials in which beauty and novelty are the selling features. Various electronic uses have also been tested. Capacitors or condensers formed from zinc-coated paper have self-healing qualities, promising longer life to such units.

### Radar Detects Meteor Showers

Radar has been pressed into service in the detection of Meteors reaching the earth. So far, it was only possible to study them only during nights, as they were not visible during the day. The possibility of studying them by day-time is a result of war research in Great Britain.

During the war, the radar instruments proved very reliable in keeping a watch over V-2 rockets coming from the Continent—both day and night. But strangely enough they recorded radio echoes repeatedly even when there were no V-2's in flight. This riddle was soon solved by Dr. J. S. Hey of the Army Research group. The mysterious echoes came, not from German rockets, but from Meteors.

It should be noted that radio waves are not reflected from the "Falling Stars" themselves, the latter usually being very small—often no bigger than a pea or a pin-head. But these minute stone or earth particles from space rush with terrific speed towards the earth, a hundred times faster than a gun bullet. When meteors reach the earth's upper atmosphere, at a height of about 100 km., the friction—the rebounding action of the air molecules—causes such intense heat that the particles normally burn. Hence the flash of the falling star can sometimes be observed for several seconds in the night sky.

During this process ionised gas molecules are created and remain in the wake of the meteor like the tail of a comet, and it is these charged gas particles which throw back the radio waves and are visible on the radar instruments. It has been shown that waves of 5-30 metre length, such as were used during World War II with radar instruments for military purposes, also give good results in meteoric research.

The chance discovery of Dr. Hey gave rise to intensive research work after the war in Britain. One decisive advantage was that radar observation could be made as well by day as by night and is quite independent of weather influences. It is, therefore, possible to follow the path of meteors during day-light and with a very cloudy sky.

As the meteor showers do not arrive until after midnight and continue on into the day, astronomers had formerly only been able to observe a part of the shower. When radar instruments were, however, set for this purpose during last May, it was found that the shower did not diminish in daylight but, on the contrary, increased, and by mid-day had attained such intensity hitherto unknown in a regular meteor shower. This phenomenon was still to be seen during the following days and throughout the month of June and into July.

### Manufacture of Phosphorus in India

The *Journal of Scientific and Industrial Research* (October 1947) reports that a pilot plant for the manufacture of 1 ton of phosphorus per day from rock phosphate has been designed at the Indian Institute of Science, Bangalore.

The annual consumption of red phosphorus in India was about 150 tons before war. The present-day requirements of Indian match and non-ferrous metallurgical industries is estimated to be about 200-250 tons.

Most of the requisite equipment for the proposed pilot plant can be fabricated in India, while the raw materials are readily available. The capital expenditure of such a plant would be about Rs. 3 lakhs, while the building and working capital will cost about Rs. 2 lakhs. The cost per pound of amorphous red phosphorus produced is estimated at 10 as. 7 p.

### Distilled Sea Water for Irrigation

The sun's rays are to be utilized in an attempt to distil sea-water for irrigation purposes in the Kathiawar, Rajputana and Sind desert areas.

Dr. J. Saidman, Director of the Pan's Institute of Actinology, Paris, has arrived in India on an invitation from the Jam Sahib of Nawanagar, where preliminary experiments on the plan are to be conducted. A resolving solarium already exists in the State.

Under the scheme, water will be boiled with the aid of the solarium, and converted into vapour. The vapour will be converted into pure water, and transmitted through large pipes to cultivated tracts. The experiment is expected to be under way by the end of next year. Dr. Saidman was confident that it would prove successful, and, if machinery were available, he hoped that the entire scheme would be completed within ten years.

Large quantities of salt would also be available. While it would be fit for human consumption, the major portion could be used for manufacturing chemicals.

### Dr. P. Venkateswarlu

Dr. P. Venkateswarlu, who is now working with Professor Niels Bohr as an International Research Fellow, has been elected to a post-doctoral research fellowship at the University of Chicago.

### Nutritional Value of Vanaspati

A comprehensive scheme of research, including nutritional and feeding tests as well as chemical studies from the scientific point of view of Vanaspati was approved for investigation at the University College of Science, Calcutta, The Indian Institute of Science, Bangalore, The Nutrition Research Laboratories, Coonoor, and the Department of Chemical Technology, Bombay. This scheme was drawn up by the Vanaspati Research Advisory Committee set up by the Council and will be financed by the Vanaspati Manufacturers' Association.

### Col. Sokhey

Col. Sir Sahib Singh Sokhey, Director of the Haffkine Institute, Bombay, left Bombay on March 15 to attend the meeting of the World Health Organisation's Experts Committee on Biological Standards to be held at Geneva from March 18th to 31st. Sir Sahib Singh will later proceed to America in connection with the penicillin project of the Government of India and also attend the International Congress on Tropical Medicine to be held at Washington in May.

### Natural Resources of States

It is learnt that a large number of major Indian States have decided to establish an "Economic Chamber of Indian States" with a central office at New Delhi to formulate a co-ordinated economic policy for the best utilisation of the natural resources of these States and to enrich them with rapid industrialisation and extend their markets to foreign countries.

In this connection, H.H. the Gaekwar of Baroda convened a conference of Rulers in Calcutta on March 14.

The Conference discussed the question of appointing a permanent Advisory Committee with scientists, meteorologists, technicians and engineers to survey and devise measures for the utilisation of the resources of the States and a Development Board which will work as liaison between the Development Departments of the Government of India and those of the Indian States.

### A New Plastic Material

The Council of Scientific and Industrial Research has developed a new patented process ready for exploitation for the manufacture of resin-impregnated sheets and boards and drawn laminated mouldings. By this process a large variety of attractive moulded articles can be manufactured which are superior to and more economical than those made from powder mouldings.

Powder-moulded products are brittle and break easily on impact whereas drawn laminated mouldings possess an extraordinary degree of toughness and will not break. Also articles possessing intricate shapes can be produced

from impregnated sheet fabric because of the inherent properties of laminate materials.

By this process articles possessing attractive styles, fancy shapes, colours and patterns, can be produced. The manufacturer is thus enabled to cover a wide range of consumer goods from household articles, furniture, decorative objects, building materials, gears, children toys and stationery.

This process utilizes ordinary resins, jute, cotton and other material available in India and the manufactured cost of impregnated laminated moulded articles is very low.

### South Indian Science Association

The Silver Jubilee of the South Indian Science Association was celebrated on the 25th and 26th of this month in Bangalore. The celebrations were inaugurated by Mr. K. C. Reddy, Prime Minister of Mysore. Sir C. V. Raman delivered the Jubilee Address on the first day. On the 26th, a symposium on "Nutrition in South India" and a discussion on the "Medium of Instructions in Science Subjects in Indian Universities" were held. Scientific and Educational Films were also exhibited on the occasion.

### Publications Received

*Conference on Industrial Development in India, New Delhi, 15th to 18th December 1947, Agenda and Notes with Reports of Departmental and Conference Committees and Resolutions passed.* (Published by the Manager, Government of India Press, New Delhi), 1948.

*Conference on Industrial Development in India, New Delhi, 15th to 18th December 1947, Proceedings.* (Published by the Manager, Government of India Press, New Delhi.)

*Patent Office Handbook.* Seventh Edition. (The Manager of Publications, Delhi), 1947. Price Re. 1.

*Dyeing Properties of Indian Cottons.* By D. L. Sen and Nazir Ahmed. (Indian Central Cotton Committee Technological Laboratory), 1947. Price Annas 12.

*Estimation of Wax Content and Feel of a Cotton from Its Physical Characters.* By C. Nanjundayya. (Indian Central Cotton Committee Technological Laboratory), 1947. Price As. 8.

*Report on the Discolouration of Bleached Bamboo and Grass Pulps During Storage.* By M. P. Bhargava and P. C. Bhatra. (The Forest Research Institute, Dehra Dun), 1947. Price Annas 5.

*Field Songs of Chhatisgarh.* (Published by The Universal Publishers, Lucknow), 1947. Price Rs. 3-12.

*Annual Report on the Health of the Army in India for the Year 1944, Vol. VII, Pt. 1.* (Published by the Manager of Publications, Delhi), 1947. Price Rs. 2-2.



# INDIAN INSTITUTE OF SCIENCE BANGALORE, 3

Applications are invited to the following posts at the Institute:—

1. Assistant Professor of Food Technology in the grade Rs. 500-25-700;
2. Lecturer in Antibiotics in the grade Rs. 200-25-350 E.B. 40/2-550.

Candidates for (1) should possess high academic qualifications and should have at least ten years of experience in teaching and research. Preference will be given to one who has worked in the field of Foods and Nutrition and has had experience in practical Food Technology; and for (2) should have had high scientific training with at least seven years of experience in teaching and research. Preference will be given to one who has specialised in the field of antibiotics.

The selected candidates will be on probation for a period of two years after which, if confirmed, they shall continue till the 30th June following the date of their attaining the age of 55 years. They will be required to contribute to the Provident Fund Scheme of the Institute, the rate of subscription being 8½% of the salary, the Institute contributing a like amount. Leave and other privileges will be as determined by the Rules, Regulations and By-laws of the Institute for the time being in force.

Six copies of applications together with six copies of all testimonials and two sets of published papers, if any (which will not be returned) should reach the undersigned on or before the 10th of April 1948.

A. G. PAI  
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## INDIAN INSTITUTE OF SCIENCE BANGALORE 3

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### *Post of Professor and Head of the Department of Metallurgy at the Institute*

It is hereby notified that the last date for the receipt of applications for the above post has been extended till the 30th of April, 1948.

A. G. PAI  
Registrar

## SCIENTIFIC GLASS BLOWER

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Applications are invited for the post of Scientific Glass Blower in the grade Rs. 100-10-200-E.B.-10-250, plus Dearness Allowance (at present Rs. 20/- per month), participation in Provident Fund, free unfurnished quarters and medical aid. Higher start may be given to candidates of great experience and skill. Apply giving full particulars before the 5th of April 1948 to the Director, Physical Research Laboratory, Shahibag, P.O. Ahmedabad.

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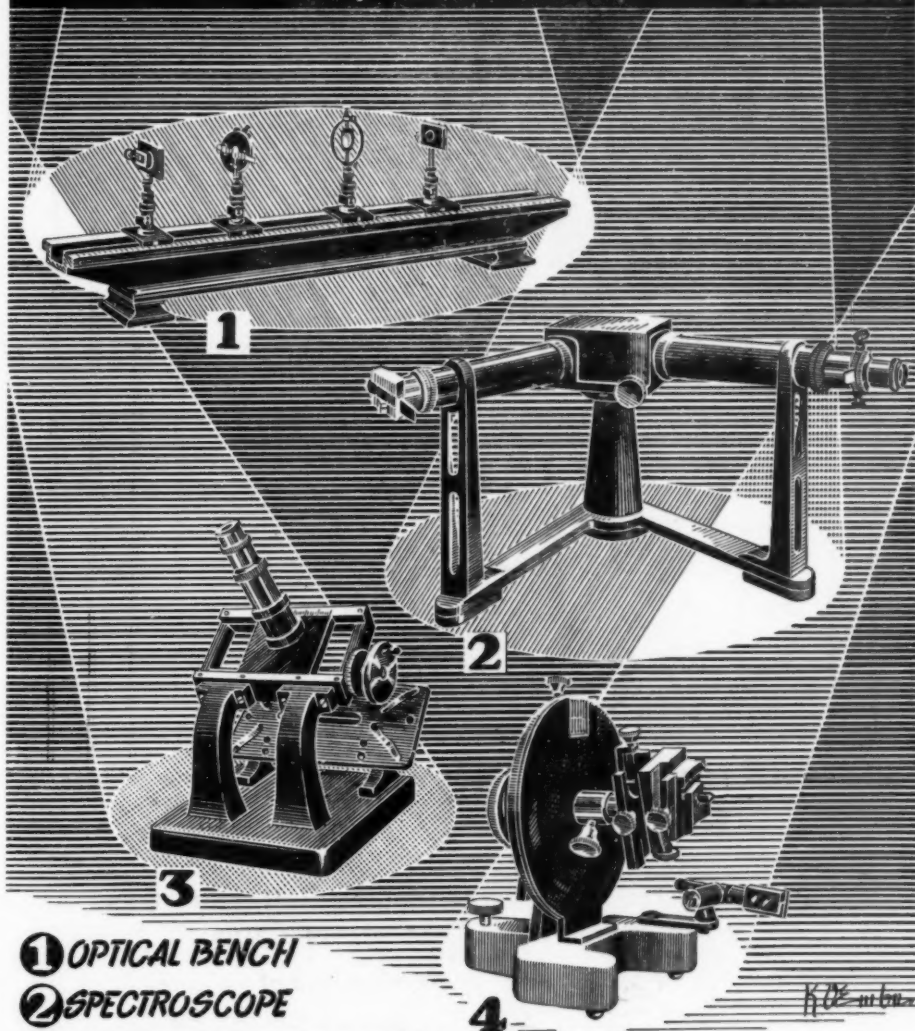
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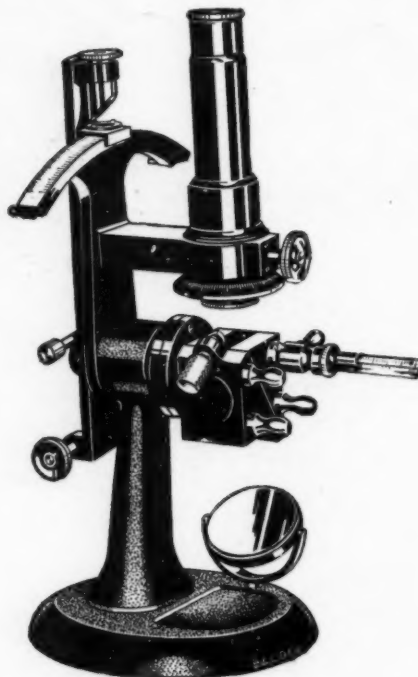
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